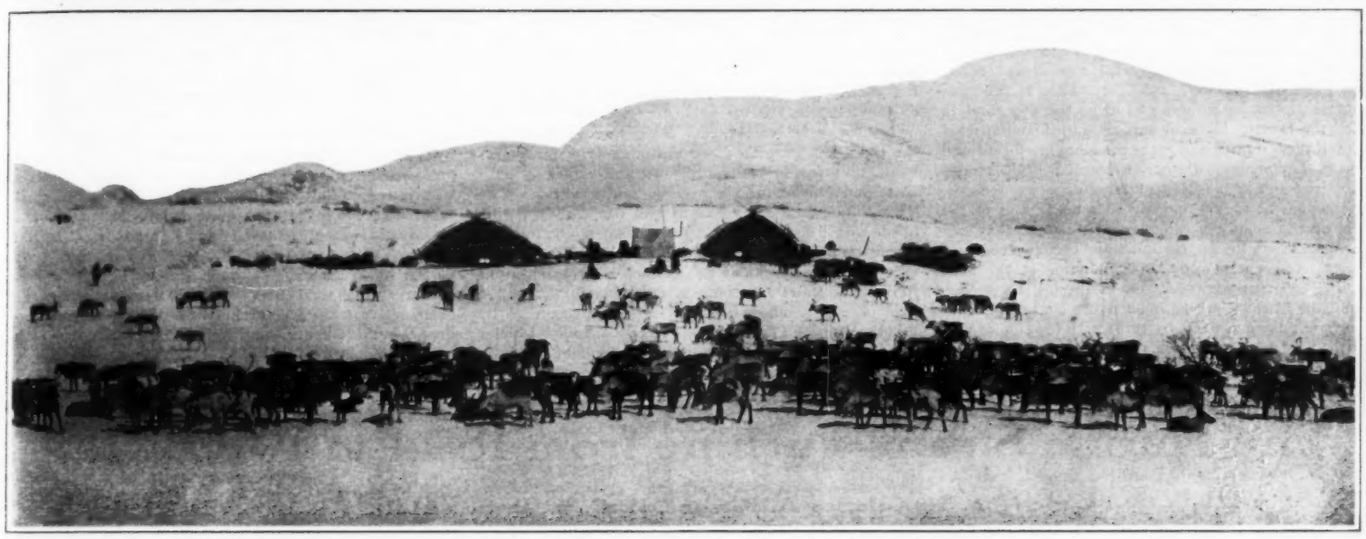
SCIENTIFIC AMERICAN SUPPLEMENT. No. 1880

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1912, by Munn & Co., Inc.
Published weekly by Munn & Co., Inc., at 361 Broadway, New York.
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXXIII., No. 1880. NEW YORK, JANUARY 13, 1912. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



Herd of Alaska Reindeer at Pasture on the Snow-Covered Tundra.

Reindeer Progress in Alaska

What the Government is Doing for the Industrial Education of the Eskimo

By Walter L. Beasly

THE herding and breeding of domesticated reindeer, introduced as an experiment a number of years ago with animals imported from Siberia by the Government, has now become the most prominent feature of the industrial education of the Eskimo and the main activity of many native villages of Arctic Alaska. The progress in civilization that has been made by lifting up the natives formerly living as savages, and eking out a precarious existence by hunting, with no other domestic animal, than the dog, to the estate of civilized, self-supporting herdsmen, as accomplished through the reindeer industry, is a remarkable educational achievement. The Alaska Reindeer Service has now reached its most successful stage, as it marks the beginning of the period of full utilization of all the reindeer owned by the Government for the benefit of the native population. At the present time there is hardly a surplus Government reindeer north of the Kuskowim River. This has been made possible by the establishment of new reindeer stations, the employment of more natives as chief herders, by accepting the largest practical number of apprentices, and by transferring reindeer to both chief herders and apprentices in lieu of salary or supplies, the chief aim and fundamental policy of the Government being to turn the reindeer over to the natives as rapidly as they learn the industry and appreciate its value. The total number of reindeer in Alaska at the last census was nearly 23,000, and of this number, over 11,000 are owned by the natives. One of the most striking and gratifying features is the large income which the natives derive from the sale of reindeer products, their share for the past fiscal year having been $18,000 and over. This amount does not include the value of the reindeer skins used for clothing nor that of the meat consumed as food. These material benefits and the very considerable income thus derived demonstrates the fact that the reindeer industry has become one of the most prominent factors in the economic life of the Eskimo. The total number of Alaskan reinder is distributed in herds among twenty-eight stations, eighteen of these being owned by the Government and ten by church missions. The Lapps own over three thousand. The natives are very anxious to get deer, and look upon them as a safe investment for their earnings, and usually take deer in preference to cash for services, when an opportunity is offered. The Government does not sell deer; this is done by natives and missions alone. The various missions are furnished a herd of one hundred deer on loan for a period of five years by the Government. At the end of this time the original number must be returned. The mission keeps the increase of fawns, which amount to several hundred, derived from the Government loan. The Moravian mission of Bethel has one of the largest herds, nearly three thousand. Other missions having over one thousand deer, all in Arctic Alaska, north of the Yukon, are located at Golovin, Kotzebue, Shishmaref, and Cape Wales. At Barrow, latitude 71 deg. 25 min., the most northern point on the American continent, there is a herd of 300. The total population here is about 400, men, women, and children. One native, Takpuk, is considered the richest man of that region, as he owns a herd of 137 reindeer. The missions support and educate a number of young apprentice herders. The native herders also take on apprentices, and award them six deer a year in pay ment for their services. The Laplanders take a loan of deer for five years from the Government, and give

The Reindeer is Trained Both for Riding and Also for Drawing the Sled.

Young White Reindeer.

Group of Lapp Herders and their Families.

their services as instructors for that period. At the end of five years the Lapp returns the 100 deer and becomes an independent herder himself with the large increase of reindeer he has obtained from the herd. The Lapp herders are not interested in the extension of the reindeer among the natives. Some of the largest owners of deer are Lapps, some half a dozen of these men having accumulated herds of from five to nearly eight hundred. In introducing the reindeer as a means to promote the industrial life and to provide a permanent livelihood for the Eskimo, it has been found necessary by the Government to put the young natives through a course of training. Those who get their deer directly from the Government, serve an apprenticeship of five years. There are several hundred of these at present. They are bound by a written contract, the strict terms of which they cannot violate without peril of losing their annual allotment of reindeer and suffering discharge from the service. This caring for, training, and breeding the deer is an education in itself, and the best which the Government could give to the young natives. With careful training the Eskimo boys make excellent herders. They readily learn how to take care of the reindeer, to throw the lasso, to harness and drive the deer, and to watch the fawns. Siberian herders were first imported to teach them, but of late years the more intelligent and efficient Laplanders, who have learned by centuries of experience the breeding of reindeer, were secured. The Eskimo boys take quickly to some phases of the work, and in some respects excel the Lapps; they can lasso better than the Lapps, and many become experts in making harness and sleds. The minding of the herd requires constant vigilance, especially in the spring, during the fawning season. Then the herders have to keep watch day and night by turns with the rifle to protect the herd from ravages of the Arctic wolf and dogs. In the ear of each Government deer a little aluminium button is fastened securely, and all private owners and herders have a mark which must be registered with the local superintendent of the reindeer station and also at Washington. Besides being taught the art of deermanship, the apprentices are instructed in keeping accounts, the methods of marketing reindeer, and in other practical matters connected with the industry. No apprentice can become a herder unless he is proficient in the branches of elementary reading, arithmetic, and writing. At the end of his apprenticeship the young Eskimo native is allotted a number of deer by the Government, and with the increase obtained during the interval of his five years service, each apprentice will have, on an average, a herd of fifty reindeer. As this herd will double itself every three years, the graduate apprentice will have a herd which will afford and assure a self-supporting income quite enough to satisfy the economic wants of himself and family in the future. He is thus established in business by the Government, and is given free pasturage thereafter. The reindeer produces one fawn in the spring each year for ten years. Among the useful and profitable products of the reindeer are the skins for clothing. Of these pelts most varied use is made. From them are fashioned the tight-fitting trousers and that wonderful outer garment, the "parka," universally worn in winter by both male and female natives and by many whites. The "parka" extends to the knees and has a close fitting hood, which keeps the head and shoulders comfortably warm even in the severest weather. These reindeer garments are remarkable for their excellent qualities of resisting moisture and cold. A close examination of the hair of the reindeer furnishes an explanation of its peculiar value. The hair is not merely a hollow tubular structure, with a cavity extending throughout its entire length, but is divided, or partitioned off, into exceedingly numerous cells, like watertight compartments These are filled with air, and their walls are so elastic and at the same time of such strong resistance, that they are not broken up either during the process of manufacture or by swelling when wet. The cells expand in water, and thus it happens that a person completely in garments made of reindeer wool does not sink when in water, because he is buoyed up by the air contained in the hundreds of thousands of hair cells. As the mineral industry continues to grow in Alaska, the natives and graduate apprentices can earn high wages as teamsters hauling supplies and furnishing fresh reindeer meat to mining camps in the interior, at points remote from railway and steamboat transportation. Well-trained sled deer have been used to carry the mail, 650 miles from Barrow, south to Kotzebue. This is the most northern mail route in the United States, and likewise the most perilous and desolate mail trip in the world.

Two trips are made a year, and $750 is paid for each journey. The average speed is about 40 to 50 miles per day, keeping up a steady trot. One of the latest and quite remarkable feats, showing the capacity of the reindeer for sledge driving, was that accomplished by Mr. W. T. Lopp, the superintendent of the Government Reindeer Service. During the recent winter's tour of inspection Mr. Lopp traveled more than 2,500 miles with a reindeer sled over the frozen tundra and ice-bound rivers of the lower Bering Sea region from the middle Yukon to the coast of the North Pacific. Part of the route for several hundred miles lay through a country which had been so little traversed that not even native trails had been made. The Alaska Reindeer Service is under the direction of the U. S. Bureau of Education.

The Marine Steam-Turbine from 1894 to 1910.—II.*

By the Hon. Sir Charles A. Parsons, K. C. B., D. Sc., LL.D., F.R.S.

Concluded from Supplement No. 1879, page 9

TYPES OF TURBINE.

There are four principal types of turbine now in use for marine work:

1. The compound class, introduced in 1894 in the "Turbinia," in which there are a very large number of turbines on drums in series, with small pressure-drops at each turbine and low steam velocities. Generally the guide vanes are identical with the moving vanes, each taking half the pressure-drop, but occasionally the moving vanes are formed like cups or buckets, and then the whole pressure-drop is taken on the guides. This class comprises 90 per cent of all marine turbines at present.

2. The multiple impulse compounded or Curtis type introduced in the "Revolution" and in the "Creole" in 1904 and the "Salem" in 1906. This system differs radically from the compound class, in that there are comparatively few stages, large pressure-drops take place at the guides or nozzles, and the high steam velocities generated are absorbed in a sinuous course between several rows of moving and fixed buckets.

3. A combination of the two types (1) and (2), in which the earlier part of the expansion is taken by the impulse type and the low-pressure part by the compound type. The impulse Parsons, with one impulse-wheel, the Brown-Curtis, with several impulse-wheels, and the A.E.G. turbines are instances of this type.

4. The multiple or compound De Laval wheel type, in which there are a large number of simple bucket wheels working in separate chambers. The pressure drops are moderate, and take place wholly in the guides, which form the passage-way from chamber to chamber. The "Rateau," the "Zoelly," the "Bergman," and others are instances.

After type (1), type (3) has received the largest use in marine work, more especially in Germany.

The compound class has low steam velocities, and there is no cutting action of the blades by the steam. Its efficiency, when the blades are of reasonable length, and leakage consequently small, is the highest, as the skin friction losses in the blades and of the moving drums and dummy pistons are small. On the other hand, when the design necessitates very short blades, as may occur at the high-pressure end, then the efficiency is reduced by leakage.

The multiple impulse type has a lower efficiency because of the skin friction losses of the steam circling through the blades at high velocity, and from the spilling of the steam from the buckets. On the other hand, it is less subject to leakage than the compound, and in the case of the first wheel of a series there is no leakage at all, and the only losses are skin friction and spilling. One impulse wheel, therefore, is a good substitute in certain cases for the initial stage of the compound, and in this design no diaphragms or shaft packings are required. The advantage of replacing several initial stages of the compound by several multiple impulse wheels in chambers separated by diaphragms and shaft packings, is somewhat questionable.

Class (4) has small leakage losses, but involves relatively more skin friction loss from the large surface of the many disks revolving in the steam.

THE COMBINATION SYSTEM.

The "Velox," in 1901, as has been stated, was the first combination vessel. The system was described and advocated by me in my Presidential Address of the Institute of Marine Engineers, in January, 1905. The "Otaki," of 464 ft. length, 9,900 tons dead-weight capacity, built and engined by Messrs. Denny, of Dumbarton, in 1908, for the New Zealand Shipping Company, was the second; the sister vessels, the "Orari" and "Opawa," were fitted with triple-expansion engines. The diagram (Fig. 6), which is taken from a paper by Engineer-Commander W. McK. Wisnom, R.N., before the Institution of Engineers and Shipbuilders in Scotland, gives the comparative results.

About the same time the "Laurentic" and "Megantic" were laid down by Messrs. Harland and Wolff, for the Canadian service. They are 565 ft. in length, and about 20,000 tons displacement. The first was fitted with triple-expansion engines, driving the side screws, and a low-pressure turbine, driving the center screw. The second vessel was fitted with the usual quadruple expansion engines and twin screws. In service it is stated that the combination vessel consumes 12 to 14 per cent less coal than the sister vessel.

In 1909 Messrs. Harland and Wolff commenced the "Olympic" and "Titanic," of 882 ft. 9 in. in length, and about 60,000 tons displacement, the arrangement of combination machinery being similar to that of the "Laurentic." With a collective horse-power of 30,000, the designed sea speed is 21 knots. The same firm is fitting the combination system in the "Demosthenes," of 19,500 tons displacement, to steam 13 knots, being built for Messrs. George Thompson and Co., Limited.

The Orient Line ordered combination machinery for the "Orama," laid down in 1910, for their Australian mail service. The vessel is 550 ft. long, and of about 18,000 tons displacement, and is being constructed and engined by Messrs. John Brown and Co., Limited, Clydebank. All these ships have triple-screws, each reciprocating engine driving a wing-shaft and propeller, while the turbine, taking the exhaust steam from both engines, works the center screw. This arrangement has the advantage that, in maneuvering and for going astern, the piston engines only are used, and thus there is no need for an astern turbine. At St. Nazaire, in France, an intermediate liner, the "Rochambeau,"* is being built, and she has four shafts, the reciprocating engines driving the inner shafts and the turbines the wing propellers.

REDUCTION GEARING BETWEEN THE TURBINE AND THE PROPELLER.

Several forms of gearing have been proposed. Electrical gearing was fitted, I believe, by the Heilmann Company, in a small vessel about thirteen years ago, but little is known of the results. Continuous-current generators and motors were originally proposed, but of late years some form of alternating-current transmission has been preferred by the advocates of the system.

Within the last few months a 50-ft. vessel has been fitted by Mr. Henry Mavor, of Glasgow, with his form of alternating-current generator and motor, and a suction-gas engine directly coupled to the generator. A quick reversal or graduation of speed of the propellers can be effected without altering the speed of the engine by this method. The efficiency of the electrical transmission is said to reach 88 per cent. The same means of transmission is applicable to the steam turbine.

An hydraulic transmission-gear has been developed by Mr. Föttinger, and has been fitted in two small vessels. The efficiency of transmission is said to reach 86 per cent. The first application of geared turbines was made by the Parsons Marine Steam-Turbine Company in a 22-ft. launch in 1897. Double helical reduction gear between the turbine and the propeller has so recently been the subject of papers before this Institution, that it is unnecessary to say more than that it promises to be an important factor in many marine turbine installations in the future. With an efficiency of over 98 per cent, and a remarkable absence of wear, it will add considerably to the efficiency of turbine installations even in fast vessels, and, what is of greater importance, it makes the turbine applicable to all classes of vessels. The London and South-Western Railway Company has recently decided to fit two new steamers of 5,000 horse-power and 20 knots speed with geared turbines. They will have twin-screws, and a high-pressure and a low-pressure turbine will be geared onto each screw shaft, similarly to the arrangement in the "Vespasian."

Although the manufacture of land turbines began to be general on the Continent in 1900, it was not till 1902 that the first turbine-propelled vessel was ordered by the French Admiralty, a torpedo boat, length 130 ft., 94 tons displacement, and 26½ knots speed. She had three shafts, and the turbines, which were built by the

* Paper read at the Jubilee meetings of the Institution of Naval Architects, and published in *Engineering*.

* Since the reading of the paper here reproduced, this boat has entered active service.

Parsons Marine Steam-Turbine Company, at Wallsend-on-Tyne, were in series similar to those of the "Turbinia," but with one cruising turbine coupled to the low-pressure turbine which drives the center shaft, and a reversing turbine in the low-pressure casing.

In 1906 a second vessel, the "Chasseur," was ordered, a destroyer of 210 ft. length, 458 tons displacement, 9,000 horse-power, and 30.4 knots speed. Her arrangement of turbines differed from that of British destroyers, inasmuch as only one cruising turbine was fitted, and the machinery was arranged in two compartments, one abaft the other. In 1906 it was decided that the six battleships of the "Danton" class should be fitted with reaction turbines. The "Danton" was the first to be completed. She was built and engined by the La Seyne Works, of the Forges et Chantier Company. She is 475 ft. length, 84 ft. 7 in. beam, and 18,374 tons displacement. The designed speed was 19.25 knots, with 22,500 shaft horse-power, but on her contract trial she maintained 20.66 knots in choppy seas, and during part of the run exceeded 21 knots.

Two more battleships were laid down in 1910 of 542 ft. length, 23,467 tons displacement, and 20 knots designed speed with 28,000 shaft horse-power. Since 1908 the French Admiralty have ordered no vessels with reciprocating engines. In 1909 a change was made in destroyer practice, all the boats being fitted with twin-screws, and in some the combination turbines with an impulse-wheel followed by reaction blading.

The first marine turbines fitted in a merchant steamship built in France were made in 1908 at the works of Cie. Electro-Mécanique for the Mediterranean steamer "Charles Roux," of 9,000 horse-power and 19 knots speed. The Transatlantic liner "France," of 688 ft. length, 25,460 tons displacement, and 23 knots speed, with steam turbines of 40,000 shaft horse-power, is now approaching completion. The "Newhaven," for the Newhaven and Dieppe service, has been completed, and has averaged 23.85 knots, as the mean of its first two cross-channel trips. In Germany the marine turbine was first introduced into the torpedo-boat destroyer "S 125," ordered towards the end of 1902. This vessel was one of the class of six boats ordered that year, the remaining boats having the ordinary type of reciprocating engines. In the following year the cruiser "Lubeck" was ordered by the German Admiralty to be fitted with Parsons turbines. A series of comparative trials were made with this vessel and a sister vessel, the "Hamburg," fitted with reciprocating engines. The results obtained on service of the destroyer "S. 125" and the cruiser "Lubeck," as compared with those of the sister vessels fitted with reciprocating engines, were conclusive in favor of the turbine boats. The destroyer "S 125" was fitted with the ordinary three-shaft arrangement of turbines, and also cruising turbines.

The turbines of the cruiser "Lubeck" were arranged on four shafts, each of which in the first trial carried two screw propellers. The shafts on each side of the ship are driven by a high-pressure and a low-pressure turbine. Cruising turbines arranged in series were also fitted. An independent high-pressure reversing turbine was fitted to each shaft. This latter arrangement has not since been repeated; such reversing turbines are now always arranged and worked in series.

Following shortly on the completion of the "S 125," the new destroyer "G 137" was commenced This vessel was the most powerful destroyer built up to that time in Germany, the turbine machinery arranged in two engine-rooms being nearly double the power of the "S 125." Designed for a speed of 30 knots, she attained 33.08 knots on a three hours' run. All destroyers subsequent to the trials of "G 137" have been fitted with turbines, and in some of the later vessels twin screws have been adopted. Following the "Lubeck," the cruisers "Stettin," "Dresden," "Augsburg," and "Ersatz Condor," were equipped with turbine engines.

In 1907 the large armored cruiser "Von der Tann" was ordered to be built by Messrs. Blohm and Voss, of Hamburg, and she has been followed by the "Moltke," "Goeben," and cruiser "J." All these great cruisers are fitted with turbines of the Parsons type, with a four-shaft arrangement similar to that adopted in recent British armored cruisers. On her contract trials the "Von der Tann" developed about 80,000 horse-power, and attained a maximum speed of 28 knots.

Reciprocating engines were fitted in German battleships until 1909, when two vessels were ordered with steam-turbines of the Parsons type. These vessels will be completed in 1912, and their trials will be of much interest, although their power and speed are inferior to those of the armored cruisers. It is understood that later battleships of 1910 and 1911 programmes are also to be fitted with turbines. The "Imperator," a new large liner building for the Hamburg-Amerika line by the Hamburg Yard of the "Vulcan," has Parsons (series) turbines, and Blohm and Voss are contracting for a second similar vessel for the same owners.

The first vessel to be fitted with Parsons turbines in the United States was the passenger steamer "Governor Cobb." This vessel, built by the W. and A. Fletcher Company in 1905, is 290 ft. long, 2,900 tons displacement,

	War Vessels.		Mercantile Vessels.		Yachts.		Total.	
	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.
Great Britain and Colonies	156	2,480,200	62	631,000	6	17,000	224	3,128,320
United States	25	392,000	6	40,000	4	12,200	35	444,200
Germany ..	26	757,600	1	60,000	..	..	27	817,600
France ..	18	292,800	4	62,000	..	..	22	354,800
Japan ..	7	213,100	7	76,000	..	..	14	289,100
Italy ..	9	163,100	2	24,000	..	..	11	187,100
Brazil ..	3	38,400	..	..	..	..	3	38,400
Argentine ..	4	72,000	..	..	..	..	4	72,000
Peru ..	..	..	2	15,000	..	..	2	15,000
Chili ..	2	50,000	..	..	..	..	2	50,000
China ..	3	19,000	..	..	..	..	3	19,000
Portugal ..	1	11,000	..	..	..	..	1	11,000
Sweden ..	1	7,000	..	..	..	..	1	7,000
Denmark ..	2	8,000	..	..	..	..	2	8,000
Spain ..	16	102,500	..	..	..	..	16	102,500
Russia ..	4	168,000	..	..	..	..	4	168,000
Austria ..	4	95,000	..	..	..	..	4	95,000
Belgium ..	..	..	3	34,000	..	..	3	34,000
Total ..	281	4,869,800	87	942,000	10	29,200	378	5,841,000

and 20.5 knots speed. The arrangement of machinery is identical with that adopted in the "King Edward." Following the "Governor Cobb," the next vessels to be designed with turbines for passenger service were the "Yale" and "Harvard," of 4,600 tons displacement, 10,000 horse-power, and 22½ knots speed; the "Old Colony," of 3,800 tons displacement and 20 knots speed, and the "Camden" and "Belfast," of 1,820 tons displacement, with a speed of 19 and 18½ knots respectively. At about the same time as the "Governor Cobb" was ordered, the United States Government placed the contract for the three scout cruisers, "Birmingham," with twin-screw reciprocating engines; "Salem," with Curtis turbines, and the "Chester," with Parsons turbines. The turbines of the "Salem" were arranged on two shafts, and in the "Chester" on four shafts in two engine-rooms, one abaft the other.

Up to the time when the scout cruisers were ordered, the Curtis type of turbine had been fitted only to a small vessel named the "Revolution," and to the mercantile steamship "Creole." It is understood that the turbines have since been removed from both these vessels. The "Salem" was therefore regarded as an experimental vessel, so far as the Curtis turbines were concerned, whereas the "Chester," with Parsons turbines, represented one of a series of cruisers of which the "Amethyst" was the pioneer.

Cruising turbines in series were fitted in the "Chester," one on each of the low-pressure turbine shafts. Astern turbines were only fitted on two of the four shafts, being incorporated in the exhaust casings of the low-pressure turbines. The comparative trials of these three vessels have from time to time been reviewed in leading technical journals. The contract speed was 24 knots, and on the full-power trial the "Birmingham" attained 24.325 knots, the "Salem" 25.947 knots, and the "Chester" 26.52 knots.

In 1907, before the competitive trials of the scout cruisers were completed, the battleship "North Dakota" was ordered by the Navy Department from the Fore River Company, and it was decided to fit her with Curtis turbines of about 25,000 horse-power, her sister ship, the "Delaware," being fitted with reciprocating engines. These two vessels were completed last year, and have been subjected to competitive trials, both under contract conditions and on sea service.

Early in 1909, on the conclusion of the tests of the scout cruisers, the Navy Department decided to adopt the Parsons type of turbines for the new battleships now building, viz.: "Utah," "Florida," of the 1908 programme, of 21,800 tons displacement and 28,000 horse-power, and later on the "Wyoming" and "Arkansas" of 26,000 tons displacement and 30,000 horse-power. The trials of the "Utah" will take place shortly,* and the future policy of the Navy Department in regard to battleships will doubtless be decided in view of the results obtained. Meantime, it has been decided to fit reciprocating engines in one battleship now building. Since 1907 all contracts for new destroyers awarded by the United States Navy Department have specified turbine engines.

In Japan four merchant vessels were fitted with Parsons turbines in 1908. Two of these, the "Tenyo Maru" and "Chiyo Maru," were built at the Mitsu Bishi Dockyard at Nagasaki, the turbines for which were constructed by the Parsons Marine Steam-Turbine Company, Limited. Two others, the "Hirafu Maru" and the "Tamura Maru," were built and engined by Messrs. Denny, of Dumbarton.

The volunteer steamers "Sakura Maru" and "Umegaka Maru" were built and engined with Parsons turbines in 1908-1909 by the Mitsu Bishi Company. The "Mogami," a despatch vessel for the Imperial Japanese Navy, was completed in the summer of 1908. There are also at present under construction for the Imperial Japanese Navy two cruisers and two high-speed destroyers with turbines of that type.

For larger warships the Japanese Admiralty have adopted Curtis turbines in the "Ibuki" armored cruiser and "Aki" battleship, both of which were launched in 1907. Both these vessels have been tried and the results published. Subsequently it has been decided to adopt the Parsons type in the large armored cruiser now building for the Japanese Navy by Messrs. Vickers, and in three sister ships to be built in Japan. The Japanese Admiralty has also taken a licence for the manufacture of the Parsons steam-turbines in the national dockyards.

In Italy the cruiser "San Marco" is the first turbine ship for the Royal Italian Navy. On her trials she attained a speed of 23.7 knots, being nearly two knots in excess of the speed attained by a sister vessel, the "San Georgio," fitted with reciprocating machinery. The "Citta di Catania" and the "Citta di Palermo," two passenger vessels of 3,500 tons displacement and 23 knots speed, were recently put on service for the Italian State Railway Company. There are under construction in Italy for the Royal Italian Navy, Parsons turbines for four battleships, and several other vessels.

All the principal navies of the world are now following the lead of the British Admiralty. In Russia four large battleships of high power are under construction. In Austria the scout "Admiral Spaun" was ordered in 1907, and on her trials she attained a speed of 27.07 knots, with 25,000 shaft-horse-power. Three battleships and 12 torpedo-boats are now on order in Austria with Parsons turbines, some of which are now building. Sweden and Denmark have recently ordered their first turbines for warships: a 7,000 horse-power set for a 21-knot cruiser in the case of Sweden, and engines of 4,000 horse-power for some twin-screw torpedo-boats in the case of Denmark. In Spain three battleships, three destroyers, and ten torpedo-boats, comprising the important recent naval programme of this navy, are to be fitted with turbine machinery. Portugal is having one destroyer built. Brazil has now two turbine scout cruisers, "Bahia" and "Rio Grande do Sul," on service. These two vessels on trial averaged a speed of 27¼ knots. The Argentine Government are adopting turbines for their four new destroyers, now being built by Messrs. Cammell Laird and Co. China is having three small cruisers built. In Belgium three turbine vessels have been built for the Government passenger line, the "Princesse Elisabeth," of a speed of 24.03 knots in 1905, and the "Jan Breydel" and "Pieter de Coninck," of speeds 24.3 knots. Peru possesses two passenger steamers, "Huallaga" and "Ucayali," of 6,000 tons and 19 knots. Canada, Australia, and New Zealand are having various war vessels fitted with turbines.

* This trial has since taken place, and the conclusions drawn from it were adverse to the turbine, owing to the greater economy of reciprocating engines at cruising speeds.—ED.

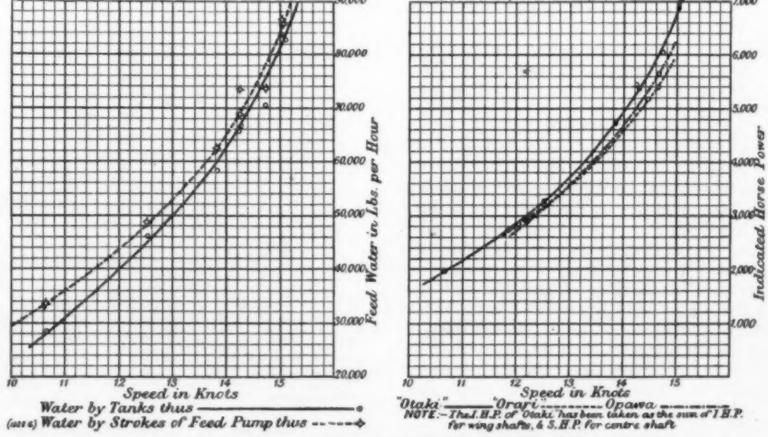

TOTAL WATER CONSUMPTION & SPEED
S.S. 'OTAKI'.
Feed Water in Lbs per Hour
Speed in Knots
Water by Tanks thus
Water by Strokes of Feed Pump thus
INDICATED HORSE POWER & SPEED.
S.S. 'OTAKI,' 'ORARI' & 'OPAWA.'
Indicated Horse Power
Speed in Knots
'Otaki'
'Orari'
'Opawa'
NOTE:—The I.H.P. of 'Otaki' has been taken as the sum of I.H.P. for wing shafts, & S.H.P. for centre shaft.

Fig. 6.—Diagrams showing comparative results.

Automatic Telephone Exchange Systems—I.*

A Survey of the Present State of the Art

By W. Aitken

IN this country† the development in the past has been almost entirely with manually operated switchboards. This type of switchboard has progressed from magneto drop indicator and call wire working, through various stages with mechanically and electrically restored indicators and branching jacks instead of series jacks, to the full common battery switchboard with parallel wiring and relays controlling lamp signals.

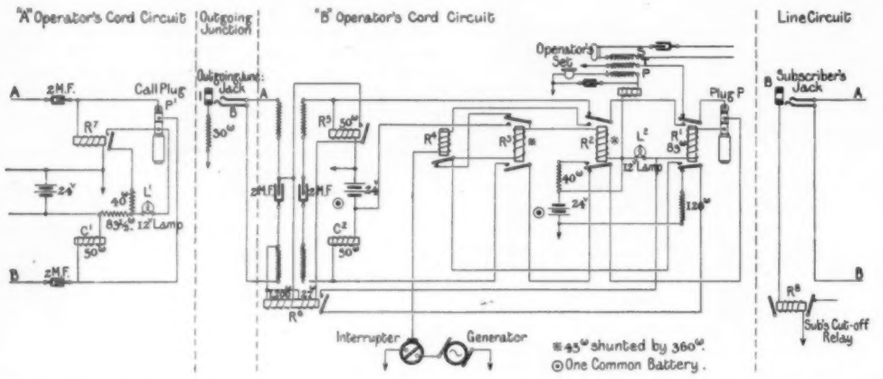


Fig. 1.—Common battery incoming junction circuit from common battery exchange, keyless ringing, calling by order wire.

From time to time automatic features have been introduced to simplify the operating, and thereby expedite the speed of connection. These automatic features have been principally introduced on the incoming junction switchboards which control the work between different exchanges in the same area, and where it is essential that the operating be of the very best. The insertion of the connecting plug into the jack of the line wanted, in addition to making the connection between the two lines, automatically cuts off the operator's testing circuit, introduces the supervisory signals, and in many cases connects up the ringing circuits so that the subscriber is automatically intermittently rung until he answers. Fig. 1 shows how this is attained.

Keyless ringing incoming junction circuits have been designed both to expedite operating and facilitate maintenance. They allow of the number of incoming junction lines per operator being increased from 27 to 36, with actually less fatigue to the operator, and, by substituting a double make and break relay for the electromagnetic ringing key, the wiring of the circuits is greatly simplified and the cost per circuit reduced.

As in the ordinary key-ringing incoming junction circuits these circuits may be arranged for either order wire or call by ringing working.

In the case of keyless circuits worked by call wire, the connections incoming at a common battery exchange, from another common battery exchange are shown in diagram Fig. 1. These are worked as follows:

The *A*, or originating operator, presses an outgoing call-wire key which connects her telephone set with that of an incoming junction, or *B* operator, at the exchange of the subscriber wanted, and distinctly articulates the number of the subscriber wanted. The *B* operator selects and advises the number of a disengaged line, and taps the tip of the associated plug *P* on the bush *B* of the multiple jack of the line asked for. If this line is free the plug is inserted and a circuit is completed which operates the 83½ ohms third conductor relay R^3. This relay automatically disconnects the operator's testing circuit *T* from the tip of the plug *P*, and puts the latter through to the tongue of the relay R^3. The *A* operator inserts her calling plug P^1 into the outgoing jack *I* of the junction allotted. A circuit is then completed from earth at the *A* position, through the winding of the supervisory relay R^7, over the *A* wire of the junction line, through the 12,000-ohm winding of the clearing relay R^2 and back to battery by the *B* wire and winding of the retardation coil C^1. This operates relay R^6 without energizing the supervisory relay R^7 and lamp L^1. Another circuit is completed from earth through the called subscriber's cut-off relay R^8 and the third conductor relay R^1, lamp L^2 to battery and earth, and in parallel with L^2, the contact of the 12,000-ohm relay R^6, and the third conductor relay R^1 to the armature of the tripping relay R^4, thence *via* the contacts of the latter and the ringing disconnecting relay R^5 (a short circuit across the coil of the relay R^3) to the relay R^3, battery and earth. This shunts out the clearing lamp. The relay R^3 then operates and completes a circuit from an earthed ringing generator through the tripping relay R^4 winding, to the tip of the plug, over the line and back to the ring of the plug, 40-ohm spool, battery and earth. The ringing current is connected to the tripping relays at regular intervals, and an earth connection is applied between the periods of ringing, by means of commutators on the ringing machines. The subscriber's bell is thus rung intermittently. When the receiver is lifted to answer, a circuit is completed through the microphone, from earth, through the tripping relay winding R^4, through the *A* wire and back by the *B* wire and 40-ohm spool to battery and earth, thereby operating the tripping relay R^4 which is insensitive to an alternating current. R^4 opens the short circuit across the coil of the relay R^3, which immediately operates and short circuits the relay R^2, which, being then de-energized, connects the *A* and *B* wires through to the repeater. The supervisory relay R^3 is then operated, the circuit being from positive of battery, winding R^3, the *A* wire, the microphone, the *B* wire, and the 50-ohm retard coil C^2 to negative of battery, and R^5 shunts the 12,000-ohm winding of the clearing relay R^2 by its 27-ohm coil, thus allowing sufficient current to flow through the supervisory relay R^7 to energize it and darken the calling supervisory lamp L^1. Once operated, the relay R^3 remains energized. When the subscriber replaces the receiver, the armature of the supervisory relay R^5 falls back and removes the 27-ohm shunt from the clearing relay R^2, and the high-resistance coil allows insufficient current to flow to keep the distant supervisory relay R^7 operated. The lamp L^1 therefore glows and the *A* operator clears, de-energizing the clearing relay R^2, thereby opening the circuit of the relay R^3 and breaking the shunt circuit about the clearing lamp L^2 which now glows. The operator clears and the line becomes normal. A 120-ohm spool is placed on the back contact of the third conductor relay R^1, so that if an *A* operator engages a junction line before the incoming plug is inserted the lamp is glowed, the incoming operator thus being automatically advised should the *A* operator plug into the wrong jack or should the incoming operator pick up the wrong plug.

It will be seen that the whole of the foregoing is quite automatic with the exception of the insertion and the withdrawal of the plugs.

The British Insulated and Helsby Cables, Ltd., have lately introduced small switchboards of my design, in which the connections are controlled by a rotary multicontact electromagnetic switch, so that when a connection is made manually, it is held electrically and automatically disconnected, and all apparatus restored to the normal condition when the subscriber replaces the telephone receiver after a conversation. At present, on small switchboards, clearing signals are given to the attendant when the telephone is replaced; but with these new switchboards the lines are automatically disconnected, and all apparatus restored to the normal condition by the replacing of the telephone. This will make the work from the private branch exchange to the central exchange much more positive, and prevent delays occurring at the central exchange due to slow operating at the private branch exchange. These boards are, primarily, designed for small exchanges where there is no regular attendant, say, up to twenty or thirty lines.

With the present class of boards it will be at once realized that slow operating will prejudicially affect the operating in the central exchange. For example, if a connection has been made, at the private branch exchange board, between the exchange line and an extension line, and the telephone at the extension instrument is now replaced after a conversation, the clearing signal will show immediately at the central exchange and at the private branch exchange. As there is no regular operator, however, at the latter, the line having been cleared at the central, another operator may connect and fail to get the private branch exchange switchboard, but would call the extension instrument, and so a delay in operating would be caused. Again, if the extension line, after clearing to the central exchange, desires a second connection to another line on the private branch exchange board, a false call will be sent in to the central exchange, again interfering with the efficiency of the operating there. Such troubles cannot arise with a

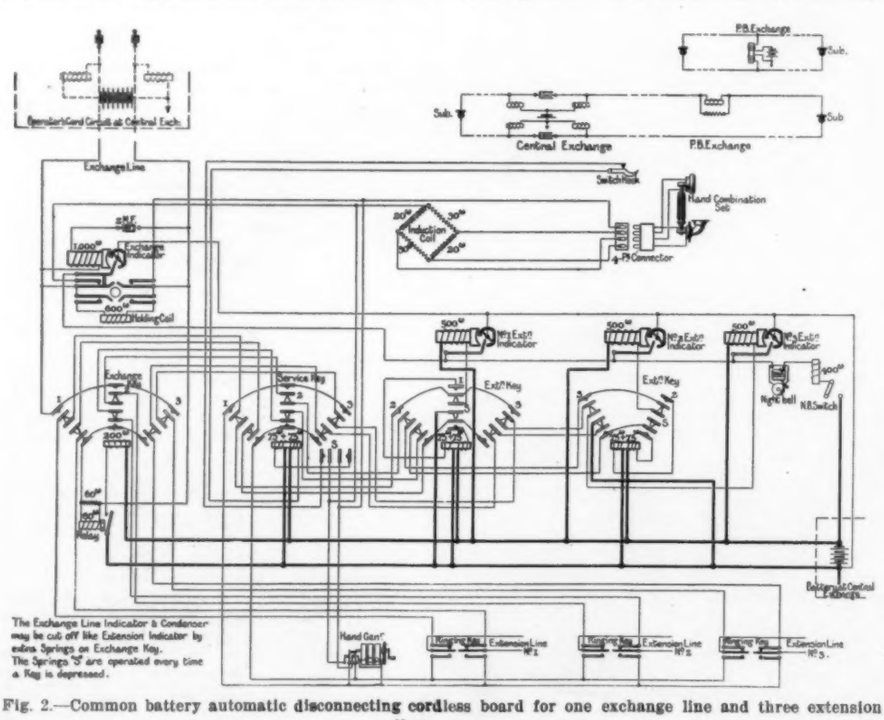


Fig. 2.—Common battery automatic disconnecting cordless board for one exchange line and three extension lines.

*Paper read before the Institution of Electrical Engineers, London, England. † England.

board giving automatic disconnection, as a second call in either direction would cause the line indicator to respond.

The multiple contact electromagnetic switch consists of a rotary selector arm which has an iron disk attached and is fitted over an electromagnet. The electromagnet sheath has the necessary groups of springs attached to connect with the number of extension lines required. Each group of springs is so arranged that when the rotary selector arm is depressed and the magnetic circuit closed, one set of springs breaks from inner ones, which disconnect the line indicator and battery of the extension line, and connect the extension line through to the exchange. The exchange speaking and holding key is linked up to the rotary switch in such a way that when the connection is completed by the rotary switch the holding key is automatically returned to the normal position.

Fig. 2 shows a diagram of connections for a board having one exchange and three extension lines, and Fig. 3 the circuit for larger boards.

On the former a complete multiple is provided, i.e., the exchange line and the service switches have groups of springs associated with all the lines; No. 1 switch has groups for all lines above No. 1; No. 2 switch has a group associated with No. 3 switch. A connection between two lines is completed by the depression of one switch.

In larger boards connector circuits are used, and these are the equivalent of cord circuits on ordinary boards. A relay is provided per line to cut off the local battery, when a connection is put through to the exchange, the electromagnet of the extension line then being in a local circuit; two plungers are depressed to complete a connection. As many connector circuits are provided as may be deemed necessary.

The operating is as follows: When a call is received from the exchange, the operator pulls over a speaking key and, at the same time, automatically restores the indicator shutter; after learning the requirements of the exchange the key is put to the holding position and the attendant rings the extension line wanted through the service switch, and after receiving a response moves the exchange multiple contact switch to 3 (if that is the number required) and depresses the key, when the current from the central exchange holds the electromagnet energized as long as the telephone is removed at the extension instrument. The winding of the electromagnet may be in series in the exchange line, and of 30 ohms resistance, and shunted by a condenser or non-inductive resistance of 70 ohms, so as not to interfere with the speaking efficiency. Instead of the switch electromagnet being placed directly in the line circuit, it may be replaced by a slow acting relay with the switch electromagnet connected in the local circuit. The advantage of this arrangement is that the switch-hook at the terminal station may be moved up and down to pulsate the lamp at the central exchange without disconnecting the circuit at the private branch exchange board. A second connection may thus be obtained through the central without the intervention of the private branch exchange operator. Where ringing current is supplied from the central exchange, the operating is improved by fitting a ringing key in connection with each extension line, so that the attendant, on receiving a demand from the exchange for an extension line, presses the ringing key and rings on the extension line until the line indicator shows a reply, and then moves the selector switch. This avoids the necessity of placing a holding coil across the exchange line while the operator is calling the extension.

When a call is received from an extension line, the attendant calls the exchange by switching into the circuit and then making a connection by the multiple contact switch. After a conversation the replacing of a telephone cuts the battery circuit, and, therefore, the electromagnet is de-energized, and a controlling spring lifts the armature and plunger, and the line is automatically severed and the line indicators thrown into circuit.

The advantages of these facilities will be appreciated by the attendant at the private branch exchange, as it is only necessary to make a connection, when all responsibility for the operating is finished. In most private branch exchange boards the night or alarm bell is used in connection with the line indicators where there is no regular attendant, so that an audible call is received; but, frequently, the night bell is not fitted in connection with the supervisory signals, so that no audible clearing signal is given, and, therefore, connections may be retained completed longer than is necessary, to the detriment of the service at the central exchange.

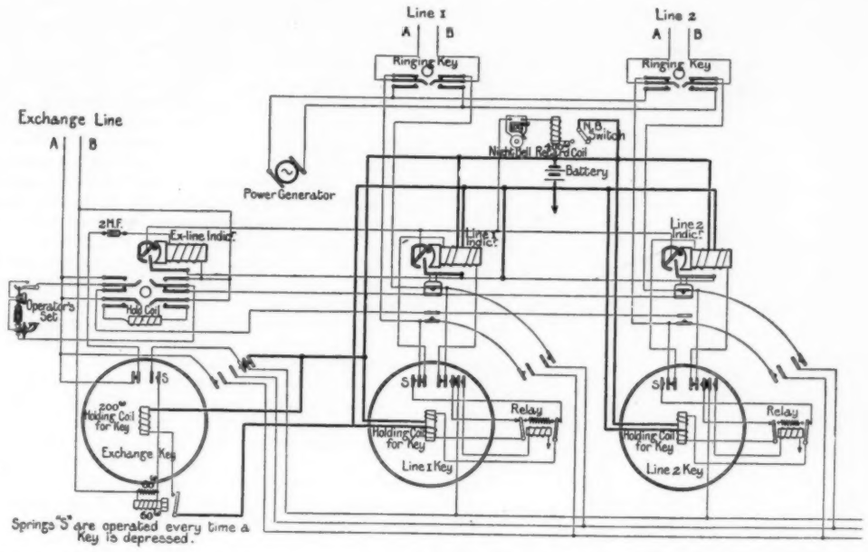


Fig. 3.—Diagram of common battery automatic disconnecting cordless switchboard for exchange service, with connector circuits and relays.

The first full automatic switchboard used in this country (Great Britain) was one patented by Mr. D. Sinclair, when engineer for the National Telephone Company, Glasgow, which was for single-wire circuits only, and was efficient for one junction line and five subscribers' lines. When a subscriber called his indicator made contact with a sliding bar which connected the calling line to the junction line to the central exchange, and insulated all the other lines. A few of these were in use in Scotland for some time.

Little more was done in connection with automatic telephony in this country—unless we take notice of exhibits made by Messrs. L. M. Ericsson of small automatic switchboards, which were in use in Sweden—until Mr. A. M. T. Thomson put forward his semi-automatic system, which was on exhibition for some time at the General Electric Company's premises about 1901.

In this system the number required was built up on the instrument and sent in to the exchange as a series of impulses which actuated an electromagnetic counter device which caused the number to be shown in front of the operator. The operator had no telephone and mechanically, by the usual plugs and cords, connected the subscriber calling with the number revealed. The transfer system of working was adopted so as to save the multiple of the switchboard, and great claims were made for excessively speedy operating, but the system was never put into actual use.

Fig. 4.—Table pattern instrument. The required number is "called" by turning the dial.

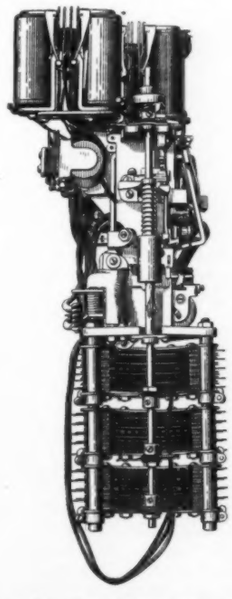


Fig. 5.—Common battery connector.

In other countries, particularly in America, automatic systems have been put forward from time to time. In the early days there was the Strowger, Faller, and the Callander systems, and later, we find the Lorimer, the American Automatic Company, and others, but the only system that has obtained commercial success and has been introduced on a large scale is what was formerly known as the Strowger system, greatly improved by Keith, and others, and now known as the Automatic Electric Company's system.

Most of the leading telephone manufacturers are now busy developing automatic systems, but, practically, there is only one system in common everyday use—that of the Automatic Electric Company, of Chicago. It is claimed by this company that there are 300,000 telephones working on their system, San Francisco, Oakland, Los Angeles, Columbus, Grand Rapids, and Chicago, being among their largest installations. San Francisco and Los Angeles are both laid out on a basis of 100,000 lines. The former has already four exchanges with three at Oakland, across the bay, most of them of 10,000-line capacity. Los Angeles has six main and four branch exchanges equipped for 25,700 lines. These exchanges are on the common battery system.

The Chicago system is just being brought into use, and is said to be suitable for 1,000,000 lines.

The greater number of exchanges are on what is known as the 3-wire system, the signalling being over the two wires alternately with earth return, but in San Francisco, and other later exchanges, all signalling is effected by the intermittent opening of the circuit at the subscriber's instrument. This has greatly simplified the subscriber's instrument.

All the facilities given on a manual exchange are now repeated on the automatic, and in some instances with a greater degree of flexibility. Junction working is practically eliminated. The ringing of the called subscriber is automatic. Calls are metered or registered (the system, however, gives free or unregistered calls when talking to officials, etc.). Party lines are efficiently dealt with, and also private branch exchanges.

In a cosmopolitan city the advantage seems to be with the automatic as regards operating by the public.

The objection is commonly urged that the subscriber cannot be trusted to operate the switch correctly, and that he should not do more than lift and replace the receiver, all operating being done by a trained staff. This opinion, I think, is only held by a few enthusiasts now. The public are being educated more and more to help themselves by automatic stamp and ticket delivery machines, and the like.

The subscriber's instrument may be of any of the well-known patterns fitted with a dial switch. The switch has finger holes near the circumference into one of which a finger is placed and the dial revolved until the finger comes against a stop.

Fig. 4 shows an instrument with the small circular switch for opening the line only. Under each of the finger holes is placed a figure, 1 to 9, then 0, and any number is made up by inserting the finger successively over the figures that go to make up the number wanted and pulling the dial round. If 637 be wanted, the finger is placed over 6, and the dial revolved to the stop, then 3 and 7 are similarly dealt with. In the 3-wire system

this dial, as it revolves, intermittently earths one or other of the wires, and thus completing a circuit from a central battery causes step by step electromagnetic mechanism to perform certain functions. In the later system these functions are now performed by the dial

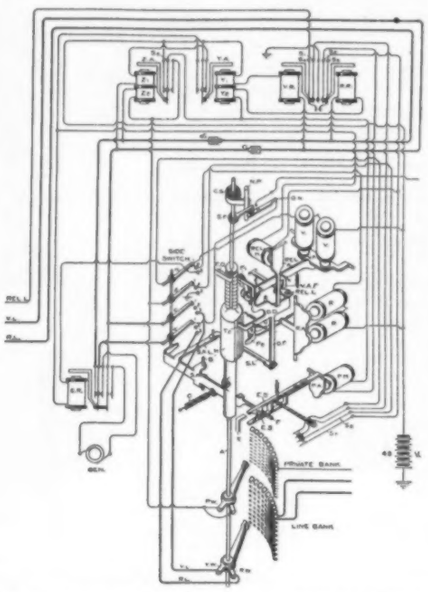


Fig. 6.—Common battery connector with its circuits.

simply intermittently opening the circuit which has been completed by lifting the receiver.

Fig. 5 shows a general view of a "connector" (the essential piece of mechanism of an automatic exchange) and Fig. 6 the diagram of connections. A small exchange might be composed only of connectors, one being provided for each line. On a frame of non-magnetic material a vertical shaft is mounted, free to lift upward and revolve. The upper part of the shaft has teeth cut round it, and below this are other teeth in the line of shaft, 10 teeth in each case. The shaft is raised and rotated by electromagnets. One called the vertical magnet, acts on the teeth surrounding the shaft, and lifts the shaft to a height corresponding to the number of impulses sent, and the number of impulses depends on the second last figure of the number required, e.g., if the number were 67, then the shaft would be raised to the height of 6 teeth. Another magnet would then be switched into action and it would act on the teeth in the line of the shaft and rotate it, the distance depending again on the number of impulses sent; in the case of the number 67 the shaft would be rotated a distance of 7 teeth. The shaft at the bottom has attached to it, and insulated from it, and from each other, contact springs or wipers, which, brush fashion, wipe over contacts associated with the lines to be called. These banks of contacts are arranged in an arc of a circle, and each line bank has 10 pairs of springs in the height, usually in two groups, and 10 contacts horizontally in the arc, wiped over by two twin contact arms. In these contacts are terminated 100 lines. A second bank is placed above this having 10 contacts in the height and 10 in the arc. These are connected to the test, or line engaging circuits which are purely local and correspond to the wires connecting the jack bushes together in a manual exchange. As the shaft rises vertically step by step, the wipers come to rest in line with the contact levels, so that when the shaft is then rotated the wipers brush over the intervening contacts in the arc, until the wipers come to rest on the contacts of the line required. When the receiver is replaced after a conversation, both lines are earthed simultaneously, or, the circuit is opened, allowing a release magnet to operate on the "dogs" (which maintained the shaft in the position brought about by the electromagnets already described) when the shaft is rotated in the reverse direction by a coiled spring until it is free to fall by gravity to the normal position.

On reference to Fig. 6, it will be noticed that these magnets are in local circuits and are controlled principally by two relays across the line circuit, and through the windings of these two relays the current for the microphone of the calling subscriber is fed in the well-known manner. (The current for the called subscriber's microphone is fed through another pair of coils on the opposite side of condensers.) One line relay is known as the vertical relay, and the other as the rotary; actually the former relay controls both the vertical and rotary movements, the latter relay being the circuit changing or switching relay. An important adjunct of the connector is the side switch which is controlled by the private magnet. This is a four-lever three-position switch.

Reverting again to the dial on the instrument, it should be mentioned that after every series of impulses corresponding to the figure of the number sent over the vertical relay wire, one impulse is sent over the opposite wire which actuates the circuit changing relay which controls the private magnet, so that this extra impulse causes the side switch to step one position after each figure, first to change from the vertical to the rotary electromagnet, and, secondly, to join the lines through. When the two lines are connected the circuit is a clean straight one, all switching apparatus being cut out of the circuit.

Should the line be already engaged this will be indicated by a vibrating tone in the calling receiver. This is brought about as follows: When the shaft is rotated the upper wiper puts earth on the local test circuit. Should another line now call for the same number the private wiper will make contact with that multipled tag while the side switch is in the second position, and this earth will complete a circuit through the release magnet, and release the shaft so that it returns to the normal position. When the subscriber rings, the shaft will be again lifted and this allows two springs to make contact which connect with the ringing current through a special interrupter which gives the engaged signal.

(To be continued)

Aerial Engineering*

Provisions at Home and Abroad for Its Scientific Study

By Prof. A. Lawrence Rotch

THE attention of the Section of Mechanical Science and Engineering was directed to aeronautics as long ago as 1886, when my distinguished predecessor, Octave Chanute, in his address at Buffalo, mentioned the possibilities of aerial navigation, a subject which entirely absorbed his later years and which he lived to see completely realized. Again in 1904, Prof. C. M. Woodward devoted a portion of his vice-presidential address at Philadelphia to a consideration of the navigation of the air, which at that time had been accomplished with dirigible balloons. Papers on aeronautical subjects, or relating thereto, have been presented in increasing numbers to the Section, reaching a maximum of eleven in 1909. Last year, the writer, as Chairman of the Section, made a special effort to secure such papers through a preliminary circular, thus worded: "The rapid advance in the navigation of the air during the past year has attracted serious attention to scientific aeronautics. The construction of dirigible balloons and flying machines is essentially a mechanical problem and as such merits consideration by this Section, especially since no engineering society has yet taken this action. Accordingly papers are invited relating to aerodynamics, and other branches of aeronautics and also the discussion of possible courses of instruction in colleges and technical schools." As a result ten papers were presented and an aeronautical curriculum was, for the first time, discussed here.

The subject of this address, "Aerial Engineering," suggests a new field for the profession, analogous to marine engineering, and one which may in the future prove almost as important. So long as the spherical balloon was the sole method of rising in the air, the technical questions involved belonged to physics and chemistry rather than to engineering, but with the advent of the dirigible balloon and the aeroplane, the mechanical engineer was called upon to provide the lightest possible motive-power and to design the framework of the balloon and the supporting surface of the aeroplane to sustain greater stresses with least weight.

The determination of the meteorological conditions at different heights and places and under all weather conditions belongs to the meteorologist, and his observations, originally made in the interest of pure science, now become of practical value. The necessity of knowing the conditions which may be encountered by air craft in their voyages through a space of three dimensions will ultimately lead to the construction of flying charts at different levels but otherwise similar to the sailing charts for the ocean. A beginning has already been made by the writer, who has published a series of twenty-four charts based on material collected by the Blue Hill Observatory in the United States and over the Atlantic Ocean. Since in the air, as on the earth, it is not the average, but the individual thing, which happens, an attempt is made to specialize for time of day and season and to show the sequence of wind changes aloft which accompanies different barometric conditions at the ground. A knowledge of the wind which varies with both place and level and depends upon the meteorological situation has a far greater importance for the air-man than for the navigator whose vessel rests on a dense and relatively stationary medium. In general the velocity of the wind increases with height and its direction becomes more constant, but the observations at Blue Hill seem to indicate that the gusts of wind, while increasing with the average velocity, decrease as we rise in the free air and are greatest near the ground in northwest winds where they may be double the average speed. In experiments there by Mr. S. P. Fergusson, as many as ten pulsations per second were recorded by the most sensitive anemometers on a wide time-sheet. The uprush of air under cumulus clouds, which is especially strong when they become cumulo nimbus or thunder-clouds, is dangerous to all air-craft that depend on dynamic equilibrium, as are the eddies termed by aviators "holes in the air," which are produced by superposed currents having different velocities or directions. It is possible for an aeroplane to fall when traveling with the wind if the gust greatly outstrips the mean velocity of the current that carries the aeroplane, which our experiments show to be a frequent occurrence near the ground, because its relative motion through the air, due to its motor, and therefore the upward component which furnishes support, is decreased by the inertia of the flying-machine preventing it from responding to the sudden impulse. The same thing may happen if an aeroplane passes suddenly up or down into a stratum having a different velocity. Such local currents and atmospheric eddies, which have long been known to meteorologists from the behavior of their kites and balloons, will now be studied *in situ* and with some danger by the aviator. These conditions may perhaps be counteracted by automatic control of equilibrium, but probably by increasing the speed and size of the machine and so rendering it less susceptible to the influence of those perturbations of the atmosphere which are often of limited extent. To-day the most needed improvements in aeroplanes are stability in wind-eddies and safety in landing. The meteorological phenomena causing difficulties are mentioned here at some length because the overcoming of these is a problem that belongs to mechanical science and therefore merits the attention of our best engineers. There is an erroneous idea that the aeroplane has been developed without laboratory experiments and a study of the theory of flight, and hence that the science of aviation does not require theoretical knowledge of the different factors which influence it. The pioneers in aviation, Lilienthal, Maxim, Langley and the Wrights, experimented in the laboratory with surfaces exposed in wind-tunnels and on whirling tables; and the best shapes for balloon envelopes to present the minimum resistance to propulsion were also obtained from models. Theoretical knowledge based on experiments is indispensable to the aeronautical engineer as distinguished from the aviator. Only on such a foundation can we build up the new science of aeronautics and such a technology as is indispensable for the development of this new branch of engineering.

M. Eiffel, the distinguished engineer, in describing the results of his recent work in aerodynamics says: "It must be admitted that experiments in the laboratory with small models can furnish data useful to aeronautical constructors, saving them both money and time in experimenting. For a series of laboratory experiments made on model aeroplanes, or on wings of small size which can be quickly and surely modified, gives the basis for later computation, either for the selection of the different members depending on the strength of the material used, or for the conditions of equilibrium and stability having regard to the calculated or assumed weight for each member. The same thing applies to a model of a screw-propeller, which, tried under proper conditions, may give information about the action of the actual propeller. The experiments with full-sized aeroplanes are almost always disturbed by wind, which introduces very large causes of error, and the trials being made necessarily with new apparatus of uncertain operation are generally dangerous. On the other hand, laboratory experiments can be conducted at any time and under different conditions and their results enable the knowledge of the engineer to replace the inspirations of the constructor, which in new fields may sometimes lead to fortunate discoveries, but may also give rise to costly mistakes.

* Address of the retiring vice-president before the American Association for the Advancement of Science, Section D, Mechanical Science and Engineering, Washington, December, 1911.

The establishment of aerodynamical laboratories, therefore, marks the entrance of aeronautics into the domain of engineering. Probably the first of such laboratories was organized by Captain, later Colonel, Charles Renard at the Central Establishment for Military Aeronautics at Chalais-Meudon, near Paris, about 1884. Here important investigations on light motors and the resistance of bodies of different shapes to motion through the air were conducted, which resulted in the first successful dirigible balloon, "La France." Experiments upon lifting screw-propellers, with a view to aviation, followed, and Colonel Renard carried on similar work until in 1903 he was succeeded by other officers and the name of the laboratory was changed.

Important experiments on the resistance of the air to falling bodies were made between 1903 and 1906 by the eminent constructor of the Eiffel Tower there, and later at his laboratory provided with a large wind chamber on the Champs de Mars. Of great importance are the determinations of the relation between the velocity and pressure of the air on a normal plane and other surfaces at varying angles of incidence, the distribution of the pressure over the surface and tests of aeroplane wings. The results of the experiments have been published in two large volumes with the detail and elegance characteristic of M. Eiffel. Another experimental establishment of wider scope has recently been created in France through the generosity of a patron of aeronautics, Mr. Deutsch de la Meurthe. This is the aerotechnical Institute of the University of Paris, located at Saint Cyr, near the Rue Aerodrome and the Satory camp, the center of military aeronautics in France. It is planned to study all theoretical and practical problems of aviation and aerostation relative to the support of bodies in the air, both at rest and in motion. The Institute is primarily a testing establishment where constructors and experimenters may bring aeroplanes, or their parts, to be tested by the best devices at actual cost, and secondarily it is an institution where aerodynamics is studied in theory and practice by experts for the government and some of the results are published as an aid to the science. The invested capital is $100,000, and an additional income of $2,000 is provided by M. Deutsch. The Director of the Institute is Prof. Maurain, who has an advisory committee composed of eminent French scientific and aeronautical experts, including representatives of the University of Paris and of the Aero-Club of France and government officials.

An earlier laboratory of the same nature in Russia was the Aerodynamic Institute of Koutchino, founded in 1904 by M. Riaboutchinski in connection with the University of Moscow. Its object is to investigate problems of pure and applied aerodynamics, general aeronautics and meteorology and three "Bulletins" containing results of the valuable investigations have been published. The initial cost of the plant was about $77,000, and the proprietor further donates some $27,000 a year for the researches.

An aerodynamical laboratory was established at Göttingen, Germany, in 1908, through the initiative of the Society for the Study of Motor-Air-ships, aided by the Göttingen Technical Association, the Government and the Krupp works, the laboratory receiving in the aggregate more than $7,000 a year. Prof. Prandtl, who also holds the chair of aeronautics in the University of Göttingen, is director of the laboratory, and has as advisers Germans prominent in physics and engineering. In Austria there are at least two private experimental laboratories.

The National Physical Laboratory at Busby Park, near London, now has an aerodynamical department, with an advisory board composed of men eminent in different branches of science, who are appointed by the Prime Minister; the chairman is Lord Rayleigh. The experimental apparatus for investigating general questions in aerodynamics includes a wind-tunnel, a whirling-table, two wind-towers for experiments in natural wind, a motor-plant and arrangements for testing the permeability of balloon and aeroplane fabrics, and the strength of light alloys for construction. A report of the Advisory Committee for 1909-10 has been published in a Government Blue Book.

There is a well-equipped laboratory in Italy for the military aeronauts and in other European countries similar establishments exist, the work of which is not disclosed.

From this rapid survey of the principal scientific establishments for the study of aeronautics in Europe, it will be seen that they may be divided into two classes; first, those privately-endowed laboratories, which are either personal or connected with some institution, but whose object is the advancement of science and practice of aeronautics; and second, those supported by the Government for military purposes, but which may publish data of value to constructors and students.

Instruction in aeronautics is now given in many foreign technical schools and universities, the best known course of study being under Prof. Prandtl at the University of Göttingen, in connection with the laboratory already mentioned. M. Basil Zaharon, a wealthy Greek residing in Paris, has endowed a chair of aeronautics at the Sorbonne with a fund of $140,000, so that France will soon rival Germany in training students in this science.

The United States are almost absolutely lacking to-day in aeronautical laboratories and technical instruction, for the brilliant researches in the past of Langley, Zahm, and Nipher have not been followed by similar work since the flying machine was realized. Our government maintains no aerodynamic laboratory, and few of our technical schools or colleges possess apparatus for this purpose, while none offer regular instruction, though some investigations have been made by advanced students. The instruction in flying by the so-called aviation schools is, of course, unworthy of consideration, since the best of these only teach the aviator to operate and repair his machine as the automobile school does for the chauffeur.

It appears likely that the demand for collegiate instruction for young men wishing to enter aerial engineering as a profession will soon require the establishment of regular courses of study based on the European curriculum, at the completion of which a degree or certificate of proficiency shall be given, ranking with that conferred in other professional courses. It seems to the writer that aerial engineering can best be taught in institutions that possess departments of mechanical engineering and naval architecture, for the preliminary training would be the same as that now given in these studies and the specialization consist in the substitution of air for water as the navigable medium. The installation of laboratories having powerful blowers connected with wind-tunnels or equipped with whirling-tables in a large inclosed space, is, of course, essential.

The Board of Governors of the Aero Club of America have requested the Committee on Aerodynamics to consider the most feasible method for organizing and maintaining an aeronautical laboratory in this country. This Committee, of which the writer is a member, has made a preliminary report through its Chairman, Dr. A. F. Zahm. The fact that the United States Signal Corps and the Bureau of Navigation of the Navy Department will probably establish such laboratories for their officers, should not prevent the creation of a civil aeronautical institution similar to those already described in England, France, Germany, and Russia. If the English precedent is followed, and the laboratory be maintained by the Government, it could properly be attached to the Bureau of Standards, but if privately endowed, like those on the continent of Europe, it might become an adjunct to the Smithsonian Institution, and this would be the more appropriate because the Institution through its late Secretary has already undertaken extensive aerodynamical researches and still possesses work-shops and a special library.

Two years ago our Chairman, Prof. G. F. Swain, in speaking of engineering as a profession, remarked that aeronautics was a peculiarly appropriate field for this Section to consider, because it had not been taken up to a considerable extent by the engineering societies. This is still true to-day, and the object of this address is to convince the members of this Section and of our engineering societies of the importance of establishing aeronautical laboratories and instruction in aerial engineering in America, in order to keep pace with their rapid development in Europe. The remarkable researches of our late associates, in this Association, Langley, the physicist, and Chanute, the engineer, which first demonstrated the principals of dynamic flight, should be an incentive to further scientific work in this country towards its perfection.

The Automobile of the Air

THE steadily lengthening death roll of aviators, which includes not merely novices but cool-headed and daring experts, has undoubtedly so dampened the confidence of the public as to materially check the development of this vehicle except for military and sensational sport.

Many investigators, including the Wrights, are experimenting with devices for eliminating as far as possible the element of peril in this new mode of locomotion, and now a member of the French Institute, M. Charles Bouchard, comes forward with a novel plan for the construction of a machine practically as safe as the ordinary family automobile, though, like it, sacrificing speed and grace to comfort and security.

The machine he proposes may be described in brief as a combination of the aeroplane, the aerostat, and the parachute.

Because of the resistance of the air, any object whose surface is sufficiently large in proportion to its weight will fall slowly, as is seen in the fluttering of a piece of paper to the ground. But the necessary weight of an aeroplane carrying two or three persons, as would be required for passenger service, would involve a spread of wing so enormous as to be unwieldy and impracticable, in the attempt to secure this slow falling in case of stoppage of the motor or other accident. This objection is ingeniously obviated by Bouchard. The requisite limitation of surface would be attained by the expedient of having double planes composed of gas-tight cloth and filled with hydrogen, whose buoyant force would counteract a portion of the weight, though the machine would still be heavier than air. Bouchard advances plausible arguments in favor of the feasibility of such construction.

"It is of importance," he says, "that the motion of a falling aeroplane should quickly cease to be accelerated and should become uniform before attaining a rate of eight meters (26¼ feet) per second, since all higher speeds are dangerous. This reduction of the speed to a constant value depends on the retarding action of the air in the resistance it offers to the surface dragged down by the weight. It is a function of the ratio between weight and surface, $\frac{W}{S}$. There is a uniform speed for each value of $\frac{W}{S}$.

Finding that calculation based on formulæ establishing the ratios between speed and air resistance led to inexact solutions, because this resistance had not been determined with regard to the shape of the surface or the sort of speed involved Bouchard made direct measurements of the uniform speed arrived at in less than two or three seconds by a falling body dragging down a concave surface. Knowing the ratio $\frac{W}{S}$ between the weight of the falling body, and the sustaining surface measured in horizontal projection, he chose this ratio in such manner that the uniform speed of descent was less than eight meters per second. These ratios he found to lie between 0.4 and 0.1.

"When $\frac{W}{S}$ = 0.4, i. e., when the weight is 4,000 grammes for a surface of 10,000 square centimeters, or about four kilogrammes per square meter, the speed is 7.69 meters (25.22 feet) per second. Hence if a ratio higher than 0.4 be taken, dangerous speeds in case of fall would be attained. It is well not to adopt a ratio lower than 0.25, i. e., 2.5 kilogrammes per square meter, with the corresponding speed of 5.58 meters (18.30 feet) per second, since below this speed and ratio stability is compromised, for apparatus too highly ballasted becomes the sport of the wind.

"Within these narrow limits 0.4 would give the aviator the advantage of carrying as much weight as possible without exceeding the moderate speed of 7.69 meters per second, comparable to that of an automobile. Even this is much lighter than any existing machine, the lighest of which is not less than 0.94.

"And here arises the difficulty which Bouchard proposes to solve by hydrogen.

"An aeroplane fully loaded cannot weigh less than 420 kilogrammes (926 pounds) which presupposes a single aviator. To insure absolute safety for this man in case of fall it would be necessary to give him the protection of an enlarged and circular sustaining surface, a veritable parachute of a diameter of 11.6 meters (38 feet). This is not unrealizable, but it is not practical. The same man cannot make observations, take notes and control such an apparatus. The military authorities wish to place three men in their machines, a mechanician, a pilot, and an observer. The general public would demand something in the way of provisions which are dispensed with in war. Hence the fully loaded weight would come to 1,140 kilogrammes (2,513 pounds). To insure a safe descent in case of a fall the diameter of the lifting surface required for this weight must be over 19 meters (62 1/3 feet). Such a machine might be made but no one would go up in it; it could not be housed in any hangar, and above all it would be exposed to attack at some part of its periphery by an eddy which would upset it.

"Therefore the transformation of the lifting surface into an always open parachute is a step toward the solution but not a complete answer.

It is necessary to reduce the weight, which may be done by the artifice of rendering it partly latent by the buoyant force of hydrogen as described above. It is estimated that each cubic meter of hydrogen will diminish the effective weight by 1,210 grammes (2.66 pounds). No advantage is gained by the use of the gas at a diameter of less than nine meters (29½ feet).

"With a diameter of 13 meters (42.65 feet) the aeroplanes thus modified will lift 1,140 kilogrammes (2,513 pounds). But 13 meters is not excessive; it is the length within a few centimeters of the Wright machine.

Oxygen Gas in the Arts and Industries

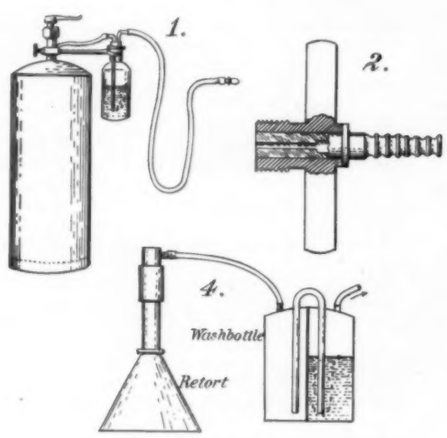
By August S. Neumark

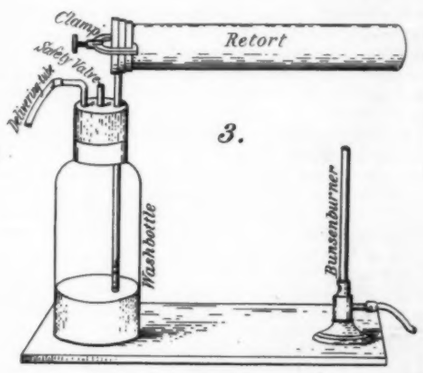
"SINCE the discovery of oxygen the civilized world has undergone a revolution in manners and customs. . . . The successful pursuit of innumerable manufactures and trades, and the separation of metals from their ores stand in the closest connection with this fact. It may well be stated that the material prosperity of the world has increased many times in this period, and that the fortune of every individual has been augmented in proportion." Thus remarked the distinguished chemist, J. von Liebig, in his "Letters on Chemistry." This was half a century ago. Since then the application of oxygen in the arts and industries has developed to a remarkable degree.

OXYGEN IN MEDICINE AND SURGERY.

The therapeutic use of oxygen dates back to its discovery. Priestley found that a mouse, confined in a limited quantity of oxygen, lived at least twice as long as in a like quantity of atmospheric air. To-day the gas is widely employed in medical practice and surgery. Among the diseases cured or at least relieved may be mentioned asthma, croup, pneumonia, dyspnœa, phthisis (and atomic diseases generally), anæmia, dyspepsia, diabetes, albuminuria, paralysis, and insomnia. The chief method of administration is by inhalation, but injection (subcutaneous) or infusion (intravenous) or introduction into the cavities of the body are also practised. Oxygen inhalation improves the quality of the blood by increasing the red corpuscles. They are of service in the later stages of pneumonia, where there is danger to life from deficient aeration of the blood; further, in chronic bronchitis of old people, and in wasting diseases. Hopeless cases of phthisis have been reported cured. Oxygen acts as a direct stimulant to the respiratory mucuous membrane, increases the force and velocity of the pulse, and has a quieting effect on the heart and respiration. It shortens the period of convalescence in typhoid fever, is beneficial in chlorosis, uræmia, dropsy, diabetic coma, tetanus, and is of distinct value in preventing and curing septic complications in gynecology. The introduction of oxygen directly into the intestinal canal may materially aid digestion, and be of service in functional and organic diseases of the liver. Hypodermic injections are useful in all conditions where the blood is not properly oxidized (sciatica, carbuncles, pleurisy, acute anæmia, pulmonary tuberculosis). It is often given in conjunction with general anæsthetics, viz., chloroform, ether, ethyl-chloride, and especially with nitrous oxide ("laughing gas"), to prolong anæsthesia, relieving cyanasis and safeguarding against cardiac or respiratory failure. Nitrous oxide mixed with 10 to 15 per cent of oxygen produces perfect anæsthesia without reducing the anæsthetic power of the former. According to Dr. G. I. Gwathmey, an anæsthetist of New York, forty thousand administrations of nitrous oxide and oxygen have been recorded without one single fatality. By warming the gases before using them, even nausea may be almost completely avoided. Nascent oxygen (i. e., oxygen at the moment of liberation) is one of the most powerful antiseptics known. Peroxide of hydrogen, which readily parts with some of its hydrogen, or oxygenated water (1 e., water saturated with oxygen) has distinct value in chronic dyspepsia, vomiting, constipation, and headaches, when taken internally. The peroxides of calcium and magnesium can also be used, as they give up their oxygen when they come in contact with the gastric juice Peroxide of zinc is used as an antiseptic dressing, while hydrogen peroxide is one of the best antiseptic washes for wounds, boils, etc. Oxygen baths, i. e., baths in which nascent oxygen is liberated by the action of a catalytic substance on chemicals which contain oxygen loosely combined (such as sodium peroxide or perborate), have beneficial effects on the circulation; cyanasis and dyspnœa has been known to vanish quickly. Oxygen is now much used as a stimulant for athletes. There is no more effective remedy than oxygen gas in cases of asphyxia and in poisoning by exposure to noxious gases such as carbon monoxide, in which the blood looses its oxygen-carrying capacity. It is the universal remedy in threatened death from inhaling poisonous gases, such as illuminating gas, benzine vapor, chloroform, ether, ammonia, sulphuretted hydrogen, smoke, sewer gases, acetylene, and "after-damp" of mines. It has further been used in opium, belladonna, chloral, and aniline poisoning, as well as in the resuscitation of the apparently drowned. The apparatus used for rescue and reviving work will be described elsewhere. The use of oxygen has been suggested for revivifying the atmosphere in public halls. Ozonized air is used in the ventilation of the Chicago Public Library. Ozone is a powerful bactericide and germicide; it purifies the atmosphere, destroys the bacilli of cholera, typhus, anthrax, etc., produces beneficial action when insufflated on wounds, and sterilizes drinking water. It may also be mentioned here that oxygen is used in Rhodesia, S. A., with marked success to combat the deadly South African horse sickness.

Oxygen gas for therapeutic use need not be chemically pure; medically pure oxygen contains between 5 to 10 per cent of nitrogen, according to the method used for preparing it. As long as nitrogen is the only impurity, it can safely be used, but it should not exceed 10 per cent. Oxygen manufactured by the electrolytic process is often of high purity (98 to 99 per cent), the impurity being hydrogen gas. Liquid air oxygen is usually of 95 per cent purity, while oxygen prepared by the alkali chlorate process contains anywhere between 5 to 10 per cent nitrogen. If not carefully purified, the gas made by the latter method may be contaminated with chlorine, carbonic acid gas, and traces of solid matter. It may hardly seem plausible, but it is nevertheless a fact, that so-called "medically pure" oxygen, as put up by the manufacturers, is very often unfit for certain technical applications (welding of aluminium, copper, brass), while most of the commercial oxygen sold for welding and like purposes could readily be used for medical purposes, being usually of 95 to 98 per cent purity. And while the latter can be bought for 1 to 2 cents per cubic foot, the cost of the former is as high as





15 cents, or even 20 cents per cubic foot. Medical oxygen is supplied in cylinders (Fig. 1) usually of 100 and 200 gallons' capacity; sometimes smaller tanks holding 50 or 60 gallons are put up. The charging pressure is 225 pounds for any of the sizes mentioned. The cylinders are provided with spindle-valves to which is attached a nozzle (Fig. 2) for the tubing connection. The gas passes from the tank to a wash bottle through which it bubbles, and from there to the mouthpiece or mask. The former should be made of hard rubber as glass is liable to break. High-pressure cylinders should be provided with a reducing valve; from there the oxygen flows through a rubber bag to insure constant pressure. In the low-pressure tanks the flow of gas can be regulated by the spindle valve, the bubbles rising in the water of the wash-bottle indicating the force of the current. In most cases the oxygen is inhaled through the mouth, although in some instances it should be administered through the nose, as in heart failure, pneumonia, and asthma, where the act of respiration is interfered with. The gas should be retained in the lungs as long as possible, and should be taken at intervals, and *not* continuously. In some cases oxygen must be used persistently. The failure to obtain results is often caused by not using the gas freely enough, or by not resorting to it until the patient is in a maribund condition. From four to eight gallons of oxygen can be inhaled without any ill effects, except perhaps a certain nervous exhilaration or a little giddiness; in larger quantities, however, it produces vertigo and narcotism. Compressed oxygen for medical purpose was sold for the first time in New York city by the New York Oxygen Gas Company in 1870, if the writer is correctly informed. This firm used the Motay and Maréchal process of manufacturing the gas. Before that time, oxygen was made in the physician's office or at the bedside of the patient, the apparatus consisting of a retort, a wash bottle, and delivery tube; the chemicals used were invariably a mixture of chlorate of potash and manganese dioxide. (Figs. 3 and 4.)

Respiratory devices of various construction are used in the mining and allied industries, in the fire department, in ice and cold storage plants, breweries, and chemical works. Such breathing apparatus are used for rescue work to save life and also to provide against loss of time. In the operation of refrigerating plants accidents occur from time to time, such as the bursting of an ammonia pipe or the breaking of a gage glass, and in such cases respiratory devices are used for rescuing anyone overcome by the deadly fumes and for making the necessary repairs without waiting until the entire charge of ammonia is exhausted. The fire department often has occasion to use oxygen helmets, when the firemen are compelled to enter places filled with smoke and noxious gases. Rescue parties in mine accidents are usually exposed to the dangers incidental to the death-dealing "fire-damp" (marsh gas); therefore emergency breathing devices are kept on hand for instant use. The following incident may be cited to fully illustrate the value of oxygen in gas poisoning: While cleaning a boiler in a German mining plant, six men were overcome by poisonous gases. With no aid in sight, the victims were left unconscious for nearly an hour, when the foreman remembered having noticed two oxygen tanks in the laboratory. These he carried to the scene of the accident, and then emptied the contents of both cylinders into the boiler. Shortly after, the men began to breathe again, and soon were able to climb ununaided through the manhole.

OXYGEN AS A BLEACH.

Oxygen gas (or ozonized oxygen) in the nascent state or in connection with bleaching powder or chlorine possesses most remarkable bleaching power, its use resulting in considerable economy. It is of special value for bleaching paper pulp, wood, straw, jute, cotton cloth and yarn, also wax, starch, ivory, animal fibers, chamois leather, stearic acid and paraffin, oils (olive oil, cottonseed oil, linseed oil) rubber goods, etc. If a stream of oxygen is passed through a mixture of paper pulp and a solution of bleaching powder, the decoloration of the pulp proceeds more rapidly than if the bleaching powder alone were used. Oxygen not only accelerates bleaching, but it also reduces the quantity of the powder necessary very considerably.. It has been proved by practical tests that a saving of 35 to 50 per cent of the bleach can be effected, while air has no such action. Hydrogen peroxide solution is sometimes used for bleaching purposes. Ivory, especially the inferior grade used for knife handles and the like, is bleached that way, also straw, textile and fiber, and white chamois leather. Nascent oxygen or peroxide solution has also been employed for the whitening of the paper of books, prints and engravings that have become stained or dingy with age.

THE USE OF OXYGEN IN THE MATURING OF SPIRITS.

If oxygen under pressure is forced into spirits or liquors and left for about two weeks, the spirit becomes mellowed to an extent equivalent to three to five years aging, nearly all of the fusel oil being converted into harmless compounds. Alcohol and wines can be improved by either passing oxygen or organized air through the liquid or by adding easily decomposed peroxides. (English Patent No. 18,422 of 1888.) For maturing whisky, oxygen has a very beneficial effect; bad whisky can be transformed into good whisky in a very short time.

Oxygen is further being used to make solid fish fat, train, and other oils. The last are heated to 90 to 100 deg. C. and then brought into intimate contact with oxygen. It is also used in the production of siccative oils and blown oils for lubricating purpose, as well as for refining linseed and palm oils. A cake of soap made of palm oil refined by this method is said to be remarkable for the delicate fragrance of its odor and its good color. Oxygen is also extensively used in the oxidation of oils as required for the manufacture of paints, varnishes, and linoleum. It does away with the use of metallic oxides and exposure to atmospheric air, and the reaction can be completed at (or below) the temperature of boiling water in from three to six hours, while before much higher temperatures had to be used for a longer period. There also was the danger from fire in boiling the oil.

The oxidation of linseed oil is effected by passing a current of oxygen in a finely divided stream through the oil (mixed with a small percentage of a drier) placed in a closed vessel, provided with steam jacket and agitator. As soon as the maximum amount of oxygen is absorbed, it is allowed to cool down to a yellow, jelly-like mass which is solid and dry enough to be packed into bags. This forms the chief ingredient of linoleum. It is mixed with rosin and ground cork, rolled on a jute canvas backing and finally seasoned at a temperature of 75 deg. C., whereupon it is ready for use.

Oxygen is being used for the preparation of *pure starch derivatives*, such as refined starch, soluble starch, dextrin and crystal gum, from common potato starch.

It has further been proposed to use oxygen gas in the manufacture of *nitrogen oxides*, the latter to be transformed into *nitric acid* and *nitrates*. This is done by enriching atmospheric air with oxygen and subjecting the gas mixture to the electric spark, thus producing oxides of nitrogen. In Germany, oxygen is used in the manufacture of *sulphuric anhydride* (SO_3), by passing a mixture of the former with sulphur dioxide (SO_2) over red-hot platinized asbestos or other contact substances.

OXYGEN IN THE MANUFACTURE OF GLASS.

The introduction of pure oxygen gas into the crucible greatly facilitates the melting of the glass; in fact an economy in fuel of 30 per cent is claimed. It hastens the operation and promotes the chemical combination of the different ingredients. It further serves to clarify the melt, resulting in a glass free from air bubbles. Oxygen is also employed in the process of glass blowing and glass marking. In the first place the oxy-coal gas blowpipe can be used to great advantage instead of the ordinary blowpipe. Lead glass can be manipulated without fear of discoloring the glass through reduction of the lead; hard glass can be marked as easily as soft glass. The use of oxygen for *glazing pottery* has also been proposed, as in this process some pottery has to be exposed in ovens (kilns) to an oxidizing agent at a high temperature.

Other applications for oxygen are its use in the production of *fused quartz* (*silica*) *vessels*, in the preparation of *natural dyes* and for *cleaning and purifying brewers' foul casks*, which is accomplished by forcing steam and ozonized oxygen under pressure alternating into the barrels. This process was found to be the only way to save many otherwise valueless beer kegs.

OXYGEN FOR THE PURIFICATION OF ILLUMINATING GAS.

The introduction of three-fourths to one per cent of oxygen into coal gas before its admission to the purifiers materially assists the purification. It practically does away with the auxiliary hydroxide of iron purifier which served to remove the sulphuretted hydrogen; the lime being alone sufficient to remove all impurities. It also increases the life of the lime and improves the candle-power of the illuminating gas. At the Ramsgate Gas Works in England, 10,000 cubic feet of oxygen (of 90 per cent purity) are manufactured daily by Brin's process. This is sufficient to purify 1,500,000 cubic feet of coal gas. To sum up, the addition of a small percentage of oxygen results in the following advantages: economy in time, in labor, and in space; simplicity in operation, immunity from nuisance, perfect purification from sulphuretted hydrogen and carbon dioxide, and higher illuminating power.

OXYGEN IN THE MANUFACTURE OF WATER GAS (DAUSON GAS).

Water gas, which in this country has nearly displaced coal gas, or at least is mixed with the latter, is obtained by the action of steam on red-hot carbon (coke). The latter decomposes the steam, forming hydrogen and carbon dioxide, which combines with more carbon to form inflammable carbon monoxide (CO). Water gas therefore is mainly a mixture of hydrogen and carbon monoxide, the gases being rendered luminous by passing the same through chambers in which oils are decomposed (carbureting). To maintain the incandescence of the carbon it is necessary to admit air with the steam. This causes a large percentage of nitrogen to be mixed with the escaping gases which greatly impair the heating and illuminating power of the water gas. It therefore would be of the greatest advantage to substitute commercial oxygen for the air, thus reducing the percentage of nitrogen and increasing the calorific value of the gas. It would be especially adapted for incandescent lights and probably result in reducing the size of the service pipes. When oxygen is added to a heavy oil gas while the latter is still hot, the illuminating power of the gas is raised; besides, it actually increases the stability of poor oil gas.

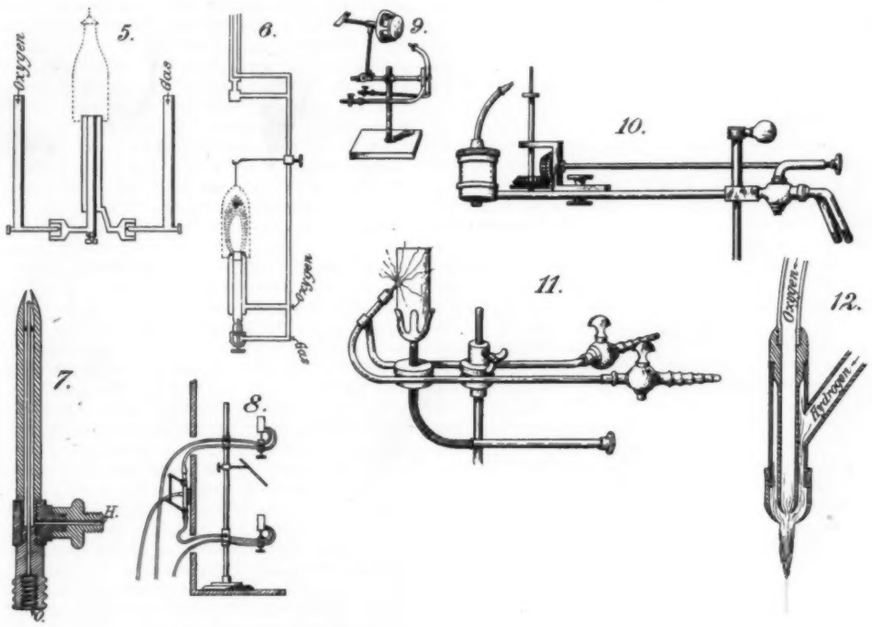
Oxygen, as is well known, is not a combustible gas, but is a supporter of combustion. If in all operations involving combustion where air is used, oxygen gas could be substituted for the latter, it is apparent that this would not only mean a great saving, but would do away with the great waste of heat energy. The development of the application of oxygen is only in its infancy, as it is only in recent years that the cost of the gas has been brought within range of practical commercial work. In a Pictet 650-horse-power plant liquid-air oxygen of 50 per cent strength can be obtained for 1/10 cent per 35 cubic feet, or 90 per cent oxygen for one quarter cent. In Claude's oxygen plants, producing 7,060 cubic feet per hour, the cost of production is three fifths cent per 35 cubic feet. Since such cheap oxygen has been produced, it has become technically and economically possible to use this gas instead of air in all operations involving combustion. In recent years it has been used in conjunction with coal gas for lighting purposes. The first burner in which oxygen was successfully used in connection with a gas flame was invented by Nürnberg of Berlin in 1904. In this burner the jacketing tube is provided with an elbow, so that the oxygen meets with some resistance during the passage to the flame and impinges upon the stream of gas at a sharp angle. This not only leads to a more perfect mixing of the gas but also keeps the flame away from that part of the burner which would otherwise suffer most from the heat. Other burners in which oxygen is used in conjunction with illuminating gas, are those of Hildebrandt, Mewes, Tresenreuter and Hecker. The latter uses a burner in which the two gases came from opposite directions. Such lights consume very little illuminating gas and produce less heat than ordinary gas lights, and are more hygienic. They can not contaminate the air as the oxygen is supplied to the flame, and not taken from the air.

Oxygen is also now being used instead of air in various *furnace processes*. The addition of 5 per cent of oxygen to the blast would reduce the capacity of the blowing engine and would increase the temperature more rapidly above the tuyeres. The escaping gases would be richer in combustibles and therefore better fuel gas. For the production of Bessemer steel the addition of oxygen reduces the time necessary for the operation. The enrichment with oxygen would save about one sixth on the fuel.

An interesting application of oxygen has recently been patented by Messrs. Menne and Zallenkopf of Germany. It consists in a method of perforating masses of metal by fusion and is particularly useful for farming blast-holes, opening of tap-holes, making holes through armor plates, and the like. This is done by connecting one pole of a circuit supplying electric current with the material to be melted through, while the other pole is connected with a pipe through which oxygen is blown. If the pipe is brought in contact with the metal for an instant, while the oxygen simultaneously flows through the pipe, the resulting short-circuit spark produces sufficient heat to start the fusion and the oxygen perforates the plate in a fraction of a minute. No electric arc is formed, as the current of oxygen prevents this, or blows it out if one should be formed. Another way to perforate the metal is to allow the formation of an electric arc for a few seconds and then allow a stream of oxygen to play on the heated place, whereby the electric arc is destroyed and the metal burnt away.

THE COMPOUND BLOWPIPE AND ITS APPLICATIONS.

The fact that immense heat is obtained when hydrogen burns has been known long ago and has given rise to the invention of a device for drawing advantage therefrom. In the year 1801 Dr. Robert Hare constructed a contrivance which he called an hydrostatic blowpipe, better known as the oxy-hydrogen blowpipe. The quantity of heat evolved when hydrogen burns in oxygen—according to Julius Thomson—is 34,116 calories for each gramme of hydrogen burned. By means of this blowpipe a temperature of 4,000 deg. F. can be obtained. Since a mixture of the two gases is liable to very dangerous explosions, they are kept in separate vessels and only allowed to mix a short distance from the tip of the blowpipe. The typical form of such blowpipe (Fig. 7) consists of an outer tubing, in the center of which a finer jet is longitudinally placed, ending a short distance from the tip. Hydrogen is admitted through the larger tube and ignited, then oxygen is directed through the inner tube. There can be no risk of an explosion if the gases are kept separate until nearly reaching the nozzle; there it will at the worst merely be a sharp "snap," which causes a sudden extinction of the flame. The latter yields but very little light, but on account of its intense heating power, has found many uses in the arts. One of these is its application to the melting and refining of the ores and alloys of platinum, which cannot be fused in an ordinary furnace. A furnace or crucible for this purpose must be constructed of a nearly infusible substance, such as calcium oxide or refractory clay. A stream of the burning gases from the blowpipe is forced through an opening in the cover, made of the same refractory material, falling on an interior crucible containing the metal to be melted. While the flame of the oxy-hydrogen blowpipe is but small and itself only slightly luminous, an intense light can be produced by allowing it to fall upon certain substances which can be heated to a high temperature without melting or burning, such as lime, magnesia and other oxides. This fact led to another interesting application of the blowpipe, namely, the *oxy-hydrogen light* (calcium light or lime light, sideral light, Drummond's light, magnesia light, zirconia light). As far back as 1820 attempts were made to obtain a safe and intense light by ignition and combustion of a piece of lime with the aid of the oxy-hydrogen flame. Goldsworthy Gurney has been the first to show that a cylinder of lime could be brought to a state of dazzling brilliancy by projecting the blowpipe flame on the former. How



ever, it was Capt. Thomas Drummond who in 1826 first utilized the lime light for practical purposes, by using it for military signals in connection with the trigonometrical survey in Ireland. At first he used oxygen and alcohol vapor (oxy-calcium light, Bude light), but later substituted hydrogen for the latter. Several years passed, however, before the oxy-hydrogen light received general attention and was put to use for the exhibition of dissolving views, for microscopic work, etc. In most cases the cheaper coal gas was substituted for hydrogen, as is still done to-day.

Attempts have been made in Europe to use the blowpipe flame for general lighting purposes. For a time lime light was used in England for lighting the Queen's barracks of the British War Department. The burners had been placed 10 feet high, the light being reflected from mirrors. During the Paris Exposition in 1867 several buildings were illuminated by oxy-hydrogen lights, and these attracted much attention. Among the buildings thus lighted were the Tuileries and the Hotel de Ville. A year later some streets and squares were provided with these lights. Each post was fitted out with five burners, each using 50 liters of hydrogen and 70 liters of oxygen per hour, giving as much light as the old lamps having nine burners and using 170 liters of carbon gas per hour. In 1870 oxy-hydrogen lights were installed at the railroad depot in Vienna. Still, illumination by the blowpipe flame never passed the experimental stage, this being chiefly due to the high cost of oxygen gas. The only other objection that was raised against these lights was that the radiating material had to be renewed daily, however, this drawback was overcome later. With an abundant and cheap supply of oxygen as produced by Claude's, Pictet's, Linde's, Hildebrandt's, and similar processes, we may expect that within reasonable time illumination by oxy-hydrogen or oxy-gas lights is sure to come into general favor. At a meeting of the Pacific Coast Gas Association a few years ago, Prof. G. A. Babrick voiced this opinion and told of some experiments he made with oxy-hydrogen lights. One lamp was placed 25 feet high at a spot where there was no other artificial light. The flame was directed against a cylinder of lime and reflected from a silver-plated mirror 15 inches in diameter. The night was dark, and still the smallest type of newspaper could be read at a distance of 250 yards. The lamp consumed a mixture of 10 cubic feet of illuminating gas and 8 cubic feet of commercial oxygen per hour. Prof. Babrick also thought that calcium light is in many ways superior to the electric arc, being devoid of the disagreeable violet color of the latter. Being exceedingly white, calcium light is well suited for the display of bright and delicate colors. The various shades and tints of a picture or dress, etc., are as plainly discernible as they are by the diffused light of the day. For the same reason lime light can be used for medical purposes, for lighting up body cavities. The intense white color makes it possible to recognize fine color-changes in the reddish mucous membrane, so that diseases can easily be diagnosed.

A piece of quicklime is mostly used as radiator for the oxy-hydrogen light; magnesia can be used instead, but zirconia (zirconium dioxide) excels both, as it compares most favorably with the electric arc. The lime is usually in the form of a cylinder (candle, pencil), the soft lime gives more light than the hard lime, but is inferior in quality and often badly centered. As minute portions of lime become detached and are volatilized from the spot on the lime on which the jet of the burning gases strikes, thus forming small grooves, it is necessary to expose a fresh surface to the action of the flame. For that purpose the lime is set in a revolving cup or dropped on a pin, which has to be turned at intervals of 10 to 15 minutes, the time depending on the pressure of the gases used. The calcium light therefore needs constant attention. A further disadvantage is that the lime cylinders have to be kept in air-tight tins and that they last only a few hours. The cracking or splintering of the lime pencils has been partially overcome. Crooks recommends the use of dalamite, a mineral composed of the carbonates of calcium and magnesium. According to an English patent, the following composition may be used. Magnesia 3 parts, precipitated chalk 6 parts, plaster of Paris 6 parts, calcium oxide 1 part, calcium phosphide 1 part, and prepared chalk 6 parts. This mass is subjected to hydraulic pressure and then baked for 3 to 5 hours. It does not absorb moisture or carbon dioxide and does not give off gas, injurious to health, during incandescence, or undergo combustion, as does quicklime. It has also been proposed to surround the lime cylinder with a tabular metal shield, leaving an elliptical aperture opposite the gas jet. This shield prevents cracking and also the formation of the white and impalpable powder often seen inside the lantern hood, caused by disintergrated calcium oxide. While it is hardly probable that lime light will ever be used for general lighting purposes, it is well adapted for illumination during brief periods, as required in carrying on important constructions during the darkness of the night, for scenic illumination of the stage, where electric light is not available, for the spectroscope, moving pictures, for the stereopticons used in illustrated lectures (Fig. 8), for medical purposes and for military operations in the field; also in emergency cases for photographing where no natural light can be obtained and where magnesium would fail owing to the dense fumes evolved. By far the best radiant body for the oxy-hydrogen flame is zirconia. This substance was used for the first time in connection with the blowpipe flame by Tessie du Motay (1860) who used oxygen saturated with a solution of napthalene in petroleum. Zirconia, if pure, remains absolutely unchanged at the highest temperature, is permanently brilliant, and does not volatilize. It is used in form of disks (buttons) or very small cylinders; their small size is an advantage in rendering them a highly concentrated source of light (Fig. 9). They last a long time and are not subject to atmospheric influences. The zirconia buttons as used by Tessie du Montay, Caron, and Linnemann were unsatisfactory. The disks broke from their base and the platinum mounting often started to melt off when it came in contact with the oxy-hydrogen flame. In 1889 Dr. W. Kochs succeeded in overcoming all difficulties. His cylinders were made by "fritting" the zirconia, using the pure earth mixed with a very small quantity of other substances. These cylinders were porous and yet sufficiently hard to be readily handled. Zirconia disks or cylinders can now be obtained in three different qualities: No. 1, for photometric purposes, lasting only 10 hours, but possessing a most intense incandescence; No. 2, for medical purposes, stereopticons, and the like, lasting 100 hours; and No. 3, for general illuminating purposes, lasting a whole month. Zirconia lights not only are as white and brilliant as the electric arc, but for certain purposes the former are even preferable to the latter, as for instance for the spectroscope and for microphotographic purposes. It is most essential for microscopic work for the light to be accurately centered and to remain so. Once set right, the zirconia light will remain unchanged for hours and always in the center of the condensing lens. The electric arc has to be "fed" from time to time to regulate the distance between the carbon points, while even in the best lime, pitting or excavation of the surface takes place, which will remove the incandescent point from the focus of the lens. It is of the utmost importance that the burners be constructed properly so that the least amount of gas at the least pressure may produce the greatest amount of heat and light. The chemical union of the gases should take place not further than one-half inch from the tip; the pressure of the oxygen must be 15 times that of the coal gas or hydrogen. Such a burner is not likely to get hot. If the oxygen pressure is not strong enough the flame may beat back and heat up the burner. The tip of the burner should be about one quarter inch from the zirconia (or lime); the angle of incidence being usually 45 degrees. A faulty flame can be easily detected with the aid of a piece of smoked glass. Black spots on the radiator indicate unburned oxygen. For scientific purposes the burners designed by Linnemann are the best on account of their accurate adjustments, for illuminating purposes they are too expensive. Those designed by Wolz are better adapted for such purposes, they consume but eight gallons of oxygen and a like amount of coal gas per hour, are self-regulating, small and most practical. Originally the mixed gases of the two parts of hydrogen and one part of oxygen were condensed by means of a "syringe" worked at a strong pressure into a square metal box from which there issued a long jet of very small bore. This jet passed through a thick oak partition in order that the operator might be protected from the danger incidental to an explosion and bursting of the metal box. This was the form of apparatus originally contrived by Clarke and Newman. Later, the safety jets of Gurney, Henning and others were adapted and the gases delivered separately. The so-called mixed-jet burners (Fig. 10), as used in England, in which the gases are mixed in a chamber—packed with wire gauze—before they issue from the orifice of the tip are to be condemned. In the "blow-through jet" (Figs. 11, 12) the oxygen only is under pressure. In this type of burner, the illuminating gas can be used directly from the service pipe or any convenient source. It also can be used in connection with a saturator. The latter consists of a chamber filled with some porous material—cotton or the like—which is saturated with ether or light gasoline (Ives patent). The saturator method (oxy-calcium light) is said to be the most economical means of producing lime light, being less costly and requiring less oxygen. Acetylene may be substituted for hydrogen or coal gas, but a specially constructed blow jet has to be employed. According to E. H. Amet, acetylene may be used with the ordinary lime light jet, provided the oxygen is mixed with nitrogen and preferably small quantities of carbon dioxide and carbureted hydrogen. He recommends the following mixture: 18,120 parts of oxygen, 11,868 parts of nitrogen, 6 parts of carbon dioxide, and a like amount of carbureted hydrogen; two parts of this gas mixture to be used with one part of acetylene (*Ozo-carbi light*). The calcium light has been used more extensively in this than in any other country. It played quite an important part during the great Civil War of 1861, where it was used for the illumination of the forts. It has further been used for signal purposes, lighthouses and during the erection of large buildings. During the construction of the Brooklyn Bridge in 1870 and 1871 twelve lime lights were in constant use. Prior to the introduction of the electric arc, they were used for stage lighting purposes. They were the most popular illuminant for the magic lantern. While the latter was looked upon in Europe as merely an optic toy, it was used in this country for educational purposes. And in spite of the introduction of the electric arc, calcium light outfits can still be found in every public school in New York city where they are used in connection with stereopticons for illustrated lectures. They may also be found in some of the public parks, where they are put to use during the concerts in the summer, and in winter for illuminating the frozen lakes for the benefit of the skaters. During political campaigns they may be seen at street corners; dance halls use them for the still popular shadow dances; they are used in the form of spot lights for private entertainments, church fairs, etc., and for moving-picture exhibitions where the electric arc is not available. For lighting purposes they are either provided with silver-plated reflectors or, if a small area is to be illuminated, open lights are used. The calcium-light outfits as seen in New York and elsewhere are, however, of the old-fashioned kind and surely in need of improvement. The uses to which these lights are put are so numerous in large cities that it has become a regular industry there to furnish oxygen and hydrogen (coal gas) in separate cylinders. The latter are of 25 or 50 cubic feet capacity, charged to 225 pounds of gas pressure, the tanks being tested to 600 pounds hydraulic pressure. The oxygen cylinder is painted red, the hydrogen cylinder black. In England the reverse seems to be the case, although for melding purposes oxygen is put up in black cylinders even in this country. It therefore seems to be a good idea to provide the different tanks and fittings with left- and right-handed threads, so that only the gas for which the cylinders are intended can be pumped in, thus preventing the possibility of any accident in filling. This method has been adopted by the British Oxygen Company in England. The cost of oxygen for calcium lights is usually 10 cents per cubic foot; the gas is in nearly all cases obtained by the chlorate process. Oxygen thus manufactured cannot be made for less than $18 per 1,000 cubic feet, the quantity being limited to 500 to 600 cubic feet per hour, using the largest retort. Therefore, oxygen used for general illuminating purposes will never be produced by chemical means. But by the liquefaction of air and its fractional evaporation we have the means of obtaining industrial oxygen in quantities to meet all requirements. By the Linde process 20,000 cubic feet of gas per hour can be produced, using a plant of 900 horse-power. The cost of oxygen as made by Pictet's method is said to be three fourths cent per 1,000 cubic feet, the gas being of 90 per cent purity; by Claude's process the cost of 1,000 cubic feet of oxygen is 1¾ cents. In the United States nearly all liquid-air oxygen seems to be used for welding and like purposes.

From the theoretical standpoint, illumination by the oxy-hydrogen flame can doubtless be regarded as the most rational system, having many advantages over electric light. Its practical use really only depends on the cost of the oxygen and on how readily this can be procured. Prof. Babrick in an address before the Pacific Coast Gas Association in 1903 declared that the United States Liquid Air and Oxygen Company would soon be able to produce commercial oxygen for 15 cents per 1,000 cubic feet. Using eight cubic feet of illuminating gas and a nearly equal amount of oxygen, a light equal to that of an electric arc consuming one kilowatt per hour can be obtained. The electric arc used for street lighting often does not exceed 1,000 candle-power, while the oxy-hydrogen flame is able to furnish a light of anywhere between 2,000 and 3,000 candle-power. To use Prof. Babrick's figures, an oxy-hydrogen light of over 2,000 candle-power would cost but little more than one half cent per hour, viz.:

8 cubic feet of gas at say 50 cents per 1,000 cubic feet =.....	$0.40
6 cubic feet of oxygen at say 25 cents per 1,000 cubic feet =.....	0.15
Cost of combined gases per hour....	$0.55

American Association for the Advancement of Science

The Recent Washington Meeting

By William Henry Hale, Member of the Council

WASHINGTON—city of magnificent distances—never had greater need to utilize all its expanse than in accommodating the meeting, December 27th-30th, of the American Association for the Advancement of Science, and the thirty-one affiliated societies. Almost every suitable place for meetings was put into service, from the Georgetown University and Volta Bureau to the Insane Asylum at Anacostia; and the occasion brought together the largest convocation of prominent scientists ever held in America. The range of subjects discussed was equally wide, extending from the most technical problems in astronomy, physics, engineering, chemistry, and biology to home economics, labor legislation, civil pensions, and the high cost of living; the program contained nearly a thousand papers.

The opening meeting on Wednesday evening drew a great crowd to the New National Museum to hear the address of President Taft, which was said to have been the first address ever made before the association by a President of the United States. I happened to learn the contrary from an old friend in the audience, whom I had known from seeing him at previous meetings. I went to Washington, supposing that my knowledge of the association antedated that of any one else who would be there, as I was present when a child at the first Albany meeting in 1851; but my friend, Col. Edward Daniels, who commanded a regiment in the civil war, told me that he had been present at the New Haven meeting in 1850, and had read a paper at the first Washington meeting in 1854, at which meeting President Pierce addressed and entertained the association; that his address contained an expression of approval of slavery, which raised a storm among the members and was ordered to be expunged from the address, and was not printed in the proceedings. Jefferson Davis, then Secretary of War, and other high officials entertained the association.

President Taft's address was timely and impressive. The feature of greatest importance was his statement that if he had the power, he would at once revolutionize the management of the United States Naval Observatory, putting it into the control of a scientific man. It is known that this wish is unanimously echoed by the council of the A. A. A. S., and their influence ought to be potent to bring about this reform.

President Taft naively remarked that Washington was a pretty good place to stay in and advised us all to prolong our stay as much as possible, adding that he himself wished to do so. This bid for a renomination naturally brought down the house.

The retiring president, Prof. A. A. Michelson, followed President Taft, reading his annual address, in which he discussed the prism and the spectrum in a manner not too technical for the occasion.

The address of Prof. A. L. Rotch before the section of Mechanical Science appears elsewhere in this issue. His recommendation that a chair of aeronautics should be established at some American university, following the lead of several European nations, must commend itself to all.

A notable feature of the whole meeting as I saw it was the increased utility of scientific research in more and better application of these results to the betterment of human conditions.

The American Economic Association for the first time met with us. Then there was the Home Economics Association, which I suppose drew the largest crowds of any, though it was held in a rather remote part of the city; and several other economic organizations, also were represented.

The cause of the high cost of living, about as practical a theme as can be, was the subject of the vice-presidential address of United States Senator Theodore E. Burton before Section I of the A. A. A. S., and was debated at great length both in this section and in the American Economic Society. In discussing this subject, Prof. Irving Fisher showed a series of charts plotting the statistics of cost of living in many countries for a series of years, which showed that the fluctuations had been world-wide, and gave resultant lines almost identical, proving that neither the trusts nor the tariff are the most important of the many and complex factors which enter into this question. One of these, as everybody now knows, is the increased production of gold at less expense than formerly; another is the decrease of agricultural productions; and there are many more. Senator Burton has given many in his address, but other speakers suggested still further causes. John Hays Hammond says semi-seriously, that he is the innocent cause of this condition as a result of his showing how to get gold from Africa cheaply. Resolutions were adopted favoring the appointment of an international committee to investigate this subject.

The regulation of trusts was another vital question discussed at length, with a consensus of opinion favoring the appointment of a commission to regulate trusts on lines similar to that of the present railroad commission.

The cause of panics was discussed together with some questions as to the reliability of statistical information as a basis for forecasts of the future. The panics to which this country is from time to time subjected are said to be due to our lack of a proper banking system. This country presents a striking contrast to all other civilized nations in this respect, and notably to Canada, because conditions in the two countries are so similar as to furnish a good basis for comparison. Bank failures are almost unknown in Canada; yet in our recent panic, when we had about one and three-quarters billion of dollars of gold, Canada had no panic, and came to our rescue by lending us $100,000,000.

R. W. Babson showed charts of fluctuations in prices of securities for a series of years, from which he argued that the course of prices thus mapped out gives a resultant line indicating that we are now ending a prosperous epoch and entering an adverse one; but Dr. John Franklin Crowell, editor of the *Wall Street Journal*, in discussing the paper, took a much more optimistic view of the immediate future.

Much attention was also given to the subject of old age pensions for civil employees, with no indication of any agreement between those who maintain that government should pension them and those who maintain that they should be compelled to pension themselves by submitting to the withholding of a part of their salary to establish a fund for these pensions. A compromise was suggested whereby government could bear part of the burden and the beneficiaries the rest.

But of all the practical and useful outcomes of this grand meeting, perhaps none is of more far-reaching importance than the resolution passed to the Economic Section, and by them recommended to the council, commending the work of Dr. Harvey W. Wiley in enforcing the pure food act against the strenuous opposition which we all know so well. For the health of the community is its greatest asset, and to secure this, good and wholesome food is a necessity, and it is because of his earnest, persistent, and successful efforts in this direction that Dr. Wiley has so long been standing on the firing line.

The matter of establishing a department of health in the United States government, which has been agitated ever since it was presented to the Economic Section several years ago, came up again in the council. A committee of prominent citizens, called the committee of one hundred, appointed by Prof. Irving Fisher as vice-president of the Economic Section, has had this movement in charge, but it proceeds so slowly that the council again adopted the resolution passed several years ago, favoring and urging it.

Health matters were considered also in the affiliated American Association for Labor Legislation, which adopted resolutions for the protection of miners; and commended the use of phosphorus in manufacture of matches.

Another important matter was the passage of a resolution recommending a law for a quarantine on plants and animals, in order to keep out blights, injurious insects, and diseases. It is estimated that the loss by preventable diseases and insects imported into this country are nearly or quite one-half of the total amount.

A resolution favoring uniform legislation which would put upon the estate the expense of experts employed in insanity cases and requiring the State and not the alleged insane persons or their opponents to call these experts, was referred to the Committee on Policy. This is a matter which has been much discussed by the American Bar Association. Certainly in our own State some reform is needed which may save the estate of persons alleged to be insane from spoliation by unscrupulous and voracious experts and lawyers.

A cordial invitation to meet at Cleveland was accepted and the date fixed as December 30th, 1912. A delegation from Atlanta urged the association to meet there, and it was resolved that we look favorably on this, but final action will be deferred till the next meeting. Also a resolution was passed favoring an attempt to arrange for a meeting on the Pacific coast, with possible excursions to Hawaii and also Alaska.

In nominating the president for the next meeting, two votes were cast for Senator Burton, who is a resident of Cleveland, the city selected for the next meeting, but Prof. E. C. Pickering of Harvard University received a very large majority, and he was elected unanimously.

Scientific Papers

WE take pleasure in quoting at length an editorial comment recently published in *The Practical Engineer*, in which the value of scientific papers is discussed. The standpoint taken is broad and generous, and shows that appreciation of scientific work of a high order, which is unfortunately too often lacking among so-called "practical men" when immediate applicability to useful ends is not plainly apparent.

"In reading closely the contributions to engineering societies, one can not help but feel that the papers presented more often than not have for their object either the cheap advertisement of some new apparatus or machine, or the glorification of the author. In fact, this matter has got to such a pitch that any paper presented to a society solely with the object of directing attention to methods of and means for ascertaining the laws underlying engineering phenomena is looked upon by the ordinary engineer as 'very pretty,' but an 'awful waste of time and materials.'

"There is undoubtedly a need for the recognition of meritorious work such as scientific societies afford by their medals and awards, but it seems that when a paper is devoted entirely to expounding the value of some invention which is the author's 'pet,' and from which he is to earn his daily bread, the reward should not be other than that which obtained from the advertisement provided by the printing and publishing of the paper.

"In engineering, as in politics, a man is to a large extent what his ancestors were. By this we do not mean that he is not in accord with the developments of the science to which he devotes his energies, but his point of view is extremely biased. It is, however, when such men prepare a paper that the most interesting discussion is obtained, for the opponent in belief feels the heat of debate upon him, and must 'let out.' Such papers are very useful, as they, along with the discussion, provide a record of two sides of the question, from which the reader can form his own judgment. Such a scientific contribution is, however, hardly likely to secure an award, as it is too partisan in character, and the committee who make the awards will be too sharply divided.

"Another class of paper deals with the problems of engineering from the point of view of pure science. It endeavors to give the 'why and the wherefore' for observed phenomena, and deduces laws from the results of numerous tests. A paper of this type is, if rightly understood, of very real value. We grant that it is possible to design a tool or machine to do work with great efficiency without a very clear knowledge of the factors which should determine the details of the design; hence the aloofness so frequently shown by the designer to the theoretical paper, but the fact remains that it is only as we assimilate the truths put before us by careful experimenters that we can hope to keep our designs to the forefront for reliability and efficiency. The user, a very important man, cares perhaps least of all for the conclusions of the seeker after the laws governing observed phenomena, for he rests upon the maker for his information as to how to use his machinery to the best advantage; but when a theoretical paper is metaphorically trampled upon, because it does not at once indicate how the earning capacity of a machine or apparatus can be increased, we think the need for technical papers is coming to an end, and the ordinary advertisement and news columns of the engineering press will suffice.

"We grant that those who attack the theoretical paper most strongly are those who, through lack of training or of intellect, can not grasp for themselves the aims of the author.

"In conclusion, we would commend Prof. Nicolson's statement: 'It is surely a good thing that now and again the records of an engineering society should be elevated above the merely mercenary and advertising element which largely prevails, so that a scientific paper may be received and welcomed which can be studied and discussed with the happy knowledge that it has no ulterior and more or less ignoble object to serve, but is intended to add possibly something to the total of human knowledge.'"

New Successes in Long Distance Transmission of Photographs

SINCE 1904, when Professor Arthur Korn (now of Berlin) made the first successful long-distance photographs over the telegraphic loop Munich-Nurnberg-Munich, he has developed the art as well as the science and seems to be on the way to still more brilliant achievements. His present object is to get more details in the picture, so that he can photograph not merely protraits, but also groups and landscapes. For such work Prof. Korn considers telautography, that is the telegraphic transmission of writing, drawings, etc, as the most suitable means. The selenium process worked out by Korn makes "toned" pictures and works with quantitatively varying current, the steps between the various tones corresponding to the varying intensity of the electric current. The telautographic process, on the other hand, uses and intermittent current of constant intensity. The selenium process gives pictures of a softness like those obtained by photography—as when, for instance, the subject is a woman's head; but for "sharp" pictures it is less suitable than telautography; in which the black portions of the picture are immediately alongside the white, and for which the original must be a pen and ink drawing or its equivalent. In the "telauto" process the photograph is first copied through a grating on a sensitive film on a thin metal sheet; the copy is then so treated that the illuminated portions are made non-conductive to electricity; the non-illuminated remaining as polished metallic surfaces. The drawing is next printed with a non-conducting ink on a metal-fill covering the rotatable sender cylinder. Around this cylinder there passes in contact a metal point, like that of a phonograph, and during its rotation the cylinder is slightly moved lengthwise of its axis, so that the point describes a close cylindrical spiral. The current, which passes through the metal point, is broken every time that the latter passes over a non-conducting —that is, an "illuminated"—portion of the picture or other original on the foil. The receiving apparatus is correspondingly arranged; the current changes the sensitive paper to blue; where it is broken at the sender, no change takes place at the corresponding point on the receiver.

Professor Korn is of the opinion that we shall soon have trans-oceanic photography.

One of our illustrations shows the telautographic portrait of President Villa of the Torino Exposition; the other is a group with the Prince of Wales in the foreground, transmitted by the telautographic process.

It may be interesting to add, although the different processes have been described in detail in our columns, a resume of their principal features.

The process with selenium at the sender is based on the property that the conductive power of this metal varies with the degree of illumination; the amount of current transmitted from a constant source through a selenium cell being greater, the more highly the latter is illuminated. A transparent photographic film is wound on a glass cylinder and the light of a Nernst lamp concentrated on a small portion thereof. The rays pass through film and cylinder and are reflected on to a selenium cell; which of course receives more light from the transparent portions of the picture; and when the proper electrical connections are made, a variable current is obtained at the receiver, where a spiral line of varying intensity is obtained as a picture. This is effected by a Nernst lamp and a cord galvanometer which varies the amount of light received on the negative from the lamp, according to the varying strength of the current.

The Prince of Wales reviewing the Boy Scouts. Telautographic transmission.

On account of the "reluctance" of the selenium (that is the fact that when brought into darkness after prolonged illumination it does not assume its highest resistance at once) it is necessary to have the receiving cylinder rotate a trifle faster than that of the sender, holding it still an instant at the end of each rotation, so that the number of rotations per minute of both is equal.

Portrait of President Villa transmitted in fifteen minutes.

The telautographic process—which really runs back to the time of Bain in 1843 and Casselli in 1860—works preferably with black and white originals although it may be used for half tones and tones. The sketch is made with non-conducting ink on metal foil; which is then rolled about a rotatable cylinder, and an interrupted electric current is transmitted by a point describing a spiral line about this cylinder and received by another, touching a sensitive paper on the receiver drum (Batewell's process.)

A variant of this process employs instead of an electro-chemical, an electro-magnetic receiver, an actual pencil being used.

Neither of these two receivers has been of much practical value, on account of their slowness of action; telautography, however, can transmit 2,000 marks in a second.

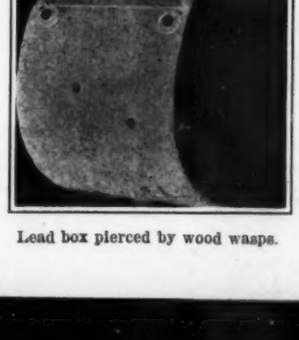
In order to transmit ordinary photographs by teleutography, they must first be copied in black and white by the well-known "half-tone" process, using a glass grating.

This winter there will be a telephoto-station in the south of France. Up to the present most of the telephoto pictures have been sent from Paris and from Manchester to London for the *Daily Mirror;* and there is also regular telephoto transmission between Berlin and Paris.

Insects Which Devour Metal

EVERY one is familiar with the disfiguring tracks or burrows left by various insects or larvæ in "worm-eaten" wood. It is not so well known that certain species, more especially the wood wasp (*sirex gigas*) will not only burrow their way through wood, but are by no means stopped even by metal, such as sheet lead and even harder materials. Some astonishing examples of this activity of the wood wasps are cited in the publications of the Paris Academy of Science, and quoted in a recent number of *Kosmos*. Our illustration shows specimens of the wood wasp, and a lead-covered box through the sides of which the insect has bored the typical circular holes. Still more astonishing than the example here shown is an instance on record, in which a packet of cartridges during the Crimean war was found perforated through and through by the larvæ of an allied species of wasp, technically known as *sirex juvencus*. In another similar case larvæ had pierced both the cartridge covers and lead balls. The lead plates of roofs and of sulphuric acid lead chambers have been found similarly perforated. Thus the occurrence can hardly be regarded even as particularly rare.

The wood wasp (Silex Gigas), which bores through wood and even metal.



Lead box pierced by wood wasps.

An Improved Method of Chipping Trees in Turpentine Orchards

AMONG the recent publications issued by the Forest Service none is more noteworthy than Dr. Charles H. Herty's Bulletin 90 entitled "Relation of Light Chipping to Commercial Yield of Naval Stores." Dr. Herty is Professor of Chemistry at the University of North Carolina, and is a collaborator in the Forest Service, having charge of experiments conducted in the turpentine orchards of the South. His experiments have demonstrated the practicability of new methods of light chipping which he put into practice on an experimental tract of long leaf pine timber at Walkill, Florida. The first part of Dr. Herty's paper deals chiefly with the results of previous experiments which he published several years ago in Forest Service Bulletin 40 and Circular 34. The most valuable part of his recent bulletin consists of a clear statement of the practical results and conclusions which are based on a great many experiments both in the field and in the laboratory. It is a treatise which is particularly strong on the practical side, and this together with his two previous publications affords a full treatment of the best methods of gathering turpentine now in vogue.

Dr. Herty proceeded on the basis that a given flow of resin can be secured as economically with considerably less injury to the trees. The old method of boxing and chipping inflicted so severe and extensive wounds upon the trees that their capacity for yielding turpentine declined rapidly and the term of operating on a given body of timber was limited to three or four years. In addition to the decline in productiveness among the living trees there was also a progressive loss of trees through death and windfall. Both the prolongation of the turpentine industry and the conservation of the timber supplies of the South called for conservative methods. How fearfully destructive the old practice of boxing and chipping the trees were in comparison with the improved methods of turpentining can be seen by a quotation from Dr. Herty's chapter "Discussion of Results":

"The combined narrow and shallow chipping, tried for only one year, showed an increased yield of dip of between 35 and 40 per cent in the single season; and in all experiments with improved methods of turpentining which have been conducted for a four-year period the principal gain has been found to be in the later years. The light cupping method showed an increased production of dip in four years amounting to 35 per cent, and in addition left the timber in condition to be immediately worked again for a second four-year period."

Showing the scarified surface resulting from the old method of boxing the trees.

As a study of the "discussion of the cause of resin flow" the circular appears defective in giving so cursory a view of Prof. Tschirch's theory of resin flow, all compressed in less than two pages, and in giving no careful consideration to either the microscopical or macroscopical illustrations. As alluded to above this circular was written by an experimentalist, and the botanical or theoretical side is almost wholly neglected or subordinated. In an appendix a number of tables are given showing in detail the yield of four different crops for four successive years, which add value and interest to the circular.

The work is recommended especially for use of the practical turpentine operator and the lumbermen of the South. It will be no less interesting to the student who is in sympathy with the present conservation movement, for if there is one field in which conservation should be practiced it is in the southern pineries. The long-leaf pine which is practically the only turpentine yielding species in this country is now being needlessly destroyed through injudicious methods of turpentining. The chief object of the circular is, therefore, to make turpentine operators advocates of a system of chipping the trees that will prove less destructive, and to make them interested in and open-minded toward all who are genuinely engaged in promoting a better and more economical use of the turpentine producing trees that are still left.

To Repair Driving Belts by Means of Chrome Glue

One hundred parts of glue are allowed to steep for twelve hours in cold water, the superfluous water is poured off, the softened glue melted in the water bath and 2 parts of glycerine and 3 parts of bichromate of potash are dissolved in it. With this solution, while still hot, the ends of the belt, previously roughened by means of a coarse rasp, are quickly coated and the belt is clamped between two hardwood boards, by means of a carpenter's handscrew. The belt is left in the clamp for 24 hours to dry.

Professors and Practical Men

"The Essence of University Finance is Collective Investment"

PROF. SMITHELL'S, of Leeds University, recently delivered his presidential address before the Society of British Gas Industries. His address is reported in *Nature* as follows:

After allusions to a boyhood spent among practical men, to subsequent university life in Great Britain and Germany, and to the tendency of English men of science with such experience to extol the German system and recommend its adoption, Prof. Smithells proceeded:

"I trust gentlemen, that if I, a mere man of science, take upon myself to talk to you about education in relation to your own pursuits, I do not neglect that vastly important element of education, that development of 'mother wit,' which comes to man as he fulfills his appointed task of wrestling in the world with men and things for his survival among the fittest.

"It is, however, man's prerogative, and it should be his delight, to possess, to use, and to extend the faculty of reason; to increase his power over the forces of nature, and constrain them to his service by a deliberate, a carefully organized, and unceasing cultivation of the human mind. The true barbarian is the man who is content to do, and does not want to know; and yet how many men are there not, whom no one could call barbarians, who look upon our system of education with a degree of distrust that increases in intensity as their survey passes upward from the elementary school to the university? This, in my judgment, is a most serious question of the day.

"I have long held the opinion that education in England is afflicted from top to bottom with an utterly exaggerated fear of what is called useful knowledge. In that fear, much of a vital kind has been left undone, and much has been given in the name of education which helps its possessor neither to truer wisdom, better work, nobler conduct, nor to greater happiness. The world cries out for educational bread, and it receives only too often an academic stone.

"I do not know that I am behind other men in the delight I feel in abstract studies, and I can honestly say it is but rarely I envy another man his larger share of loaves and fishes; but knowledge gathered for what is sometimes called its own sake, and treasured for its own sake, seems to me in great danger of unwholesomeness, and a learned man, who is merely a man of erudition, to be as likely to prove a mischief as he is certain to be a bore.

"At the head of our educational system stand the universities. A university is, or should be, in essence a mine and a mart for the highest learning. It was in its origin an adjunct to those callings which made the greatest demand upon the powers of thought. You may put it more picturesquely, no doubt, but it suits my purpose best to use homely terms, for I believe too little stress has been placed upon the real beginning and the original purpose of universities as institutions standing in direct relationship to definite callings. It is, I believe, because our university system has not kept pace with the great changes that have taken place in the character of human occupations, that universities have failed to secure or to retain the sympathy of a large section of the community. The great delay in the development of research and instruction in natural science in the universities led to a corresponding delay in the dissemination of elementary scientific knowledge through our schools, and in consequence we find to-day in the older generation of our more educated citizens, to say nothing of those less educated, a whole legion of men whose knowledge of science would not correspond in terms of their grammar to knowing the difference between a noun and an adjective, in their geography the difference between latitude and longitude, and in their Latin to that between Cicero and Cæsar.

"Now I lay great stress upon this lack of the general dissemination of scientific knowledge, because people sometimes say to me that, after all, we have surely had many distinguished men of science in our universities for generations past. It is true; but they were not preparing a market for their wares; they were elaborating in their seclusion something which was utterly mysterious to the average man. Even to-day people come occasionally into my laboratory with the air of men entering a hall of mystery or a chamber of horrors, fearful of what may befall them. Again, people say to me, surely the industrial fruits of scientific knowledge have long been recognized. True, again most palpably true, but how the fruit is related to the knowledge, how the seed is sown, how it is tended, what should be done to nurture the plant, that is not known. It is not known because your educational system did not achieve this one thing for the community—it did not put its victims for a single occasion in their lives in the position of asking a simple scientific question and faithfully finding the answer by experiment.

"Now the portion of knowledge which most completely and vitally interpenetrates our manufactures is natural science, and it has been, I think, an incalculable disadvantage that, while these manufactures were advancing by leaps and bounds during the century succeeding the industrial revolution (which I suppose may be dated about 1760) there was no movement in the educational world for a general dissemination of scientific knowledge and skill. During that period several misconceptions took deep root in the English mind. The achievements of Arkwright the barber, Hargreaves the weaver, Crompton the farmer, Watt the instrument maker, Cartwright the clergyman, Stephenson the fireman, Murdock the millwright, and of all that illustrious group—their great and fundamental achievements created an overwhelming belief that the self-taught inventor was destined to be the only important pioneer in industrial discovery; and to this day a young man brought up on a diet of grammar and Samuel Smiles might well despair of contributing anything of moment to the service of industry, unless, indeed, he happened to be exceptionally poor and to have attended no more showy a place of education than a night-school.

"If the universities had set themselves to send a current of science through our schools at the time when the direct utility of scientific knowledge and of scientific method was becoming demonstrable in the industrial world, we should, I think, be in a very different position to-day, and our universities would hold a very different

place in the esteem of our countrymen. It is this historical retrospect, and the experience of the frantic and wasteful struggles in my own lifetime on the part of the worker to come to terms with the thinker, that have made me realize the dangers that attend academic seclusion, and have left me well content that my lot as a university teacher is cast within earshot of the throb and hum of busy workshops.

"Of all that we have lost in the course of events I have described, nothing is more difficult to retrieve than confidence in the practical usefulness of university science. We are suspected at every turn of trying to elude the practical man, and to betake ourselves to studies and impart information the glory of which lies in its detachment from all things mundane and remunerative. We have engendered the suspicion that we are intellectually exclusive and that we do not understand, or sympathize with, the practical point of view. A better understanding between us is, I think, a matter of the greatest national importance, and it has seemed to me that if a better understanding is to be attained, it is incumbent on the universities to go out so far as ever they can to meet the legitimate claims of the industrial community, and to bring their studies deliberately into the closest possible relationship with the industrial arts.

"I think I may claim that in this university (Leeds), we have shown no lack of courage in doing so. In spite of a good deal of academic apprehension and distrust, not always kindly expressed, from outside critics, we have established departments of work for the explicit purpose of furthering the special pursuits of industry, much in the same way and in the same spirit as schools of law, medicine, and theology were established in bygone days.

"Another thing, on which I would lay the greatest stress, is that we have secured in the direction of our university as a whole, and of these special departments in particular, the active co-operation of men of business and of representatives of the particular industries concerned. I do not look upon these steps as a gracious concession, still less as a sordid opportunism. I believe they secure the best interests of thought as surely as I hope they will serve the most immediate needs of work.

"No one who has studied the history of science can be ignorant of the fact that science has its roots and has gained its greatest impulse in the practical avocations of mankind. Chemistry was born in foundries and pharmacies, and nearly every great advance can be traced to some industrial impulse. I suppose the greatest achievement in chemistry were those of Lavoisier. How did they arise? I believe I am not wrong in saying that it was in the preparation of his prize essay on the best mode of lighting the streets of Paris. Beginning with a consideration of the best form of lamp, the most effective form of reflectors, the most suitable shape of oil containers, Lavoisier passed to the study of combustion, and finding organic things like oil and tallow too complex to reveal the fundamental nature of the process, he betook himself to simpler things like phosphorus and zinc, and so was led to the train of discoveries which constitute the foundations of modern chemistry. 'It was,' as M. le Chatelier has said, 'this constant preoccupation with practical questions that enabled Lavoisier to escape without effort from the fictions and conventions amid which contemporary chemists were marking time.'

"I have given you but one of innumerable examples to illustrate a truth that we who profess science should never be permitted to forget, and to assure you that I regard the close association of universities with the business world as of enormous advantage to the universities. We have in this, I believe, the true corrective of academic excesses, the best stay for academic frailties; and I believe the good understanding and mutual respect which we may hope to bring about between the leaders in the spheres of labor and of learning will be extended rapidly through the rank and file.

"I hope you will find in what I have said so far, the evidence of a desire to acknowledge some of the shortcomings of the academic world. But I might well be suspected of having had my head turned by the dignity you have conferred upon me if I left you under the impression that I thought the faults were wholly on one side. In what remains of the time at my disposal I wish to confide in you some of the difficulties of the situation which arise from the other side.

"I believe that a very large number of business men go wrong when they enter upon the consideration or criticism of educational affairs by attempting to apply methods and standards and principles borrowed from their own callings, which, however excellent in their proper place, do not apply, or at least do not apply in the same way, to education. Let me remind you, in the very first place, that you can, for example, prepare no balance-sheet of a university. You know how much money comes into the university chest and how much is paid out, but how much a university costs or how much it earns no man can discover. Suppose, for example, in my zeal to find employment for a student, I send you a young chemist who, by his unrestrained ardor or incompetence, misleads you into all kinds of futile extravagance, surely you would debit that to the university. I do not doubt you would. Every care is taken that such things are brought home to us. Suppose, on the other hand, I send you someone, like a former student I met last week, who, by what he had learned here, increased the output of his employer's business by 33 per cent. Should that not be credited to the university if by someone's indiscretion you happened to hear of it? I think so. In a business like ours it transcends the powers of any accountant to effect an audit; you would need a whole secret service of educated spies. You, individually, may give us a thousand pounds in the hope of a return, but you, individually, may get nothing in return—at least in this world—or you may get a return that you cannot trace to its source. No; *the essence of university finance is collective investment.* It is, to some considerable extent, selective for a locality, and may be made equally so for a single group of interests or industries; but, looking at a university as a whole, it is national, or even international, in its financial ramifications.

"If I and many of my colleagues in this and other universities are of some value to this country, I would have you remember that the cost of our education has to a quite considerable extent fallen upon the German tax-payer.

"If I say that the students who have gone from our chemical department are collectively earning half a million a year for the firms who employ them, no one can contradict me; and I am tempted to affirm it positively as a counterblast to those hasty financiers who look at our accounts and raise their voice in lamentation over the capital we lay down, without stopping to think of the unrecorded dividends that accrue.

"I will take another thing. I think a good business man, while anxious to progress and branch out, while ready to take risks and go somewhat afield for promising expedients or appliances, is usually very careful not to lose sight of the main current of his affairs, expecting to profit by deliberate methodical plans rather than by totally unexpected accidents.

"The same is doubtless true within the pursuit of science itself, where the object is simply to elucidate a given problem. But when it comes to the contact between science and industry, an entirely new factor appears.

"The discovery of the atmospheric burner was not an accident. It arose from the desire of Bunsen to have a gas flame that would not smoke his flasks, and it was contrived by a stroke of genius. But what an accident for you that a man of genius should want a smokeless flame! When I was a student in Bunsen's laboratory there came to it Carl Auer von Welsbach, in the spirit of an unalloyed philosopher, eager to solve some problems about the group of chemical elements that seemed, of all, the most remote from any daily human needs. He noticed the remarkable glow of the mixed oxides when a flame impinged upon them, and so begat the mantle. Again, I say, no accident for him, but ahgain, what a accident for you, that a man of genius sould want ton investigate the mystery of rare earths!

"I need not ask you where the gas industries would be to-day without these windfalls from the tree of scientific knowledge, the scientific branches of which, be it remembered, wave most vigorously in the upper air. By what definite planning are you to get discoveries of this kind made? The answer is, I think, by treasuring your men of genius and letting them work in the light of their genius. Surely the time has gone by to wonder whether true scientific work, carried on in the spirit of a philosopher by a man of genius with his feet upon the earth, subserves the material needs of humanity. Who is there that will dare to set his finger on any patch of new natural knowledge and say: 'This may be edifying, but it is nothing to us'?

"When, therefore, you seek to bring science into your service, beware of unduly fettering the minds and discriminating the topics. This seems to be the hardest lesson of all for the Englishman to learn. His very straightforwardness and stern common sense, his business-like ways, may all conspire to make him unbusinesslike in matters of education and research, to which, believe me, a man must serve a long apprenticeship before he becomes a master craftsman. I will listen eagerly to a business man while he tells me what he wants; I will eagerly seek the real knowledge that he has to give; I will eagerly lean upon him in the manifold business of administration; I will eagerly take his money; but when he wants to tell me that I shall teach this and not teach that, that this is useful, the other useless, above all, when he talks as if a well-constituted university should give proficiency in the practice of trades and render apprenticeship superfluous—well, I do not listen to him very patiently, and I say to myself, 'Alas, that this man should think himself practical!'

"If we on our side come to take a more sympathetic and direct part in bringing science to your service, I plead that you on yours shall show a larger measure of faith, of hope, and, I might almost say, of charity. Do not try to constrain us in our own proper business; do not be impatient of returns. They are sure to come; history has abundantly proved it; but you must freely cast your bread upon the waters."

The Adherence of Flat Surfaces

Atmospheric Pressure Accounts Only for a Small Fraction of the Adhesive Force

A RECENT communication to the Royal Society, says *The Engineer*, describes some investigations made by Mr. H. M. Budgett into the phenomenon exhibited by the adhesion together of two accurately plane, polished surfaces of steel. It has long been known that two such surfaces will adhere with much greater force than can be accounted for simply by the pressure of the atmosphere. In 1875 Prof. Tyndall determined the force necessary to pull two Whitworth surface plates apart, and as he found that this force was still considerable when the experiment was conducted in a vacuum he came to the conclusion that molecular attraction was, in part at least, responsible for the adhesion. This view has since become generally accepted. In the light of Mr. Budgett's recent work, however, Tyndall's theory must go, and we must now attribute the phenomenon to the presence of a very minute film of liquid between the surfaces.

The fact that some steel gauges did not always cling together with the same force first attracted Mr. Budgett's attention to the subject. Then it was discovered that two blocks left wrung together for a long time required the use of a vice and hammer to separate them. When taken apart it was seen that the faces had rusted together, indicating that initially moisture had been present between them. Such a film would, of course, be readily formed if the blocks before being wrung together had been held in warm hands. Hence Mr. Budgett was led to try the effect of wringing two blocks together from which all trace of moisture and grease had been removed by cleaning the faces with alcohol. It was found that adhesion vanished, and that the blocks fell apart under their own weight.

A number of hardened steel blocks, each weighing 1½ ounces, and having faces of 0.7 square inch in area, were prepared and polished flat to within a millionth of an inch accuracy. With these the adhesive properties of various liquids were examined. The faces of two blocks were first carefully cleaned with alcohol and then smeared with a very fine film of the liquid under examination. The blocks were then wrung together by a combined sliding and twisting motion. The force required to separate them was measured on a spring balance. With any given liquid there was a considerable variation in the pull required to separate the blocks. This was due to the difficulty of gaging the thickness and uniformity of the applied film and an element of uncertainty in wringing the blocks together. But, taking the average of many trials with each liquid, Mr. Budgett got the following results for the force necessary to separate the blocks: Condensed water vapor, 35 pounds; turpentine, 29 pounds; paraffin, 27 pounds; oil of almonds, 24 pounds; lubricating oil 22 pounds; olive oil, 20 pounds; sperm oil, 18 pounds; Rangoon oil, 17 pounds. Volatile liquids, such as alcohol, benzine, and petrol, gave no adhesion. Viscous liquids, such as glycerine, treacle, and glucose, gave very little adhesion. By rubbing the blocks on the hands after washing with soap, values as high as 90 pounds were obtained for the adhesion.

To determine how much of the adhesion was due to atmospheric pressure, the blocks were separated in a vacuum. The average of twelve readings in air was compared with the average of twelve readings in a vacuum. The vacuum readings were, of course, lower than the air readings, but the difference is much less than most would expect. As the area of the faces of the blocks is 0.7 square inch, one would expect the atmospheric pressure to be responsible for about 10.25 pounds of the adhesion. But it was found that the difference between the air and vacuum readings never rose above 3.9 pounds (for Rangoon oil), and was as low as 1.1 pounds (for paraffin). It is clear then that air pressure was having access to a large part of the surfaces supposed to be in contact. If it be assumed that

the film is continuous over the area of the faces, then F, the force necessary to pull the blocks apart, is expressible as $F=2\ AT/d$, where A is the area of the faces, d their distance apart, and T the surface tension of the liquid. F A and T being known, d can thus be calculated. Taking the constants for paraffin, it was found that the faces were theoretically 0.000005 of an inch apart.

Microscopic examination of the smeared faces, however, revealed the fact that the film was not continuous, but really composed of small drops, which in the process of bringing the blocks together were drawn out into fine lines. The total length of these lines was measured, and assuming that the separation of the blocks took place by the rupturing of the fluid, Mr. Budgett calculated what proportion of the rupturing force was due to surface tension. In the case of paraffin he found that not more than 1 pound could be attributed to this cause. Hence, of the total force of 27 pounds required to pull the plates apart when paraffin is the medium composing the film, 1.1 pounds may be attributed to the pressure of the atmosphere and 1 pound to surface tension. The remaining 25 pounds or so are due to the actual tensile strength of the liquid. By microscopical examination Mr. Budgett came to the conclusion that not more than one-tenth of the surfaces was covered by the liquid. Hence the tensile strength of paraffin is 24.9÷0.07, or 355 pounds per square inch. Similarly, for water the tensile strength is found to be 443 pounds, and for turpentine 371 pounds per square inch. These values are very much higher than those previously thought to be correct. In conclusion, we may state that Mr. Budgett has found that soft metals will not stand the stress put upon their surface by the film of fluid. Pieces of the polished surface may actually be dragged out in the effort to rupture the film. This effect is very noticeable in the case of glass. It is essential, therefore, that optical proof planes should be perfectly free from grease before use, as otherwise they will be ruined. Opticians do take this precaution, but it is probably more as a matter of routine than from any known reason why it should be necessary.

International Commission on the Cost of Living

A Movement of World-wide Scope and Importance

WITH the support of leading economists, financiers, editors, and statesmen, a movement has been launched to secure the appointment of an official international commission on the cost of living.

The objects of the proposed commission are:

1. To gather all available facts as to recent changes in wages, cost of living and prices generally throughout the world, and to make international comparisons.
2. To secure evidence as to the main causes of these changes and of international differences.
3. To discuss possible remedies.

I. THE FACTS.

The price statistics hitherto published are very limited in scope and are not fitted to indicate the price movements of the civilized world. Such index numbers of prices as have been published are usually confined to the wholesale prices, and in all cases cover only a small part of the field of general prices and wages, even where the statistics are of the best, as in the United States, England, and Germany. Moreover these index numbers are constructed by different methods in different places and in consequence are not mutually comparable. Thus a recent attempt of the English Board of Trade to compare its index numbers of prices for "foods and materials" with corresponding statistics elsewhere required a reclassification of the latter by which certain commodities were introduced, others omitted, and still others transferred from "foods" to "materials" and *vice versa*.

A complete study of the facts would afford a general view of the differences between different countries and times so far as concerns:

(a) The purchasing power of the dollar or other monetary unit.

(b) Purchasing power of incomes, especially wages.

These two sorts of purchasing power do not always change together. Thus, if all prices and wages rise equally, it is clear that the purchasing power of the monetary unit must fall, though the purchasing power of wages will have remained the same. But if the rise in the prices of goods for which wages are spent is greater than the rise in the wages themselves, it is clear that there has been not only a diminution in the purchasing power of the monetary unit, but also a diminution in the total purchasing power of the wages, that is, a diminution in "real wages."

Both problems are of the greatest importance and the prospect of adding to our knowledge as to either of them would be a sufficient justification for the creation of the proposed commission. It is believed that the commission can throw light on both problems; for the raw materials for constructing index numbers exist in published and manuscript documents in every commercial country and only require clerical work under intelligent direction in order to be wrought into index numbers of real value.

II. THE CAUSES.

Here also the commission will have two problems:

(a) To explain the fall in the purchasing power of the monetary unit.

(b) To explain the changes in the total purchasing power of incomes, especially wages.

The first problem (a) is that of the rise of prices and will resolve itself chiefly into two parts: (1) a study of money and (2) a study of goods. The former will include a study of the production of gold, the extension of credit through the use of checks, uncovered bank notes, modern methods of indorsement, underwriting, etc., and the velocity of circulation of money; the latter will include a study of the conditions of production, transportation, and the volume of trade in respect to agricultural, mining, and industrial products.

The second problem (b) is that of the factors influencing the world's supply of food and other commodities which bear upon the great mass of consumers, as well as changes in standards of expenditure, concentration of population in cities, and all other factors which affect the people in their capacity as consumers.

III. THE REMEDIES.

The commission will again be confronted with two problems:

(a) The problem of preventing changes in the purchasing power of the monetary unit, as for instance through monetary or banking legislation; and

(b) The problem of increasing or at any rate of preventing any decrease in the total purchasing power of wages, by combating mal-nutrition and the decay of industrial efficiency.

Those chiefly interested in the project of a commission on the cost of living do not agree on any remedy or remedies. They are agreed merely on the importance of the questions involved. The commission would not, of course, be authorized to bind the various nations represented to the adoption of any plans that might be recommended. It would simply aim to express the best unbiased scientific conclusions which they may find from a more complete study of facts than has hitherto been made.

Should it happen that the commission reported favorably any plan requiring political co-operation, the way would then be open for the various nations to enter into diplomatic negotiations looking toward such co-operation, just as was the case when the "Latin Union" was formed to secure uniformity in currency or when various nations agreed to prohibit the poisonous match industry.

WHY THE COMMISSION SHOULD BE INTERNATIONAL.

The commission should be international because the problems are necessarily international. Even the inflation of the currency of one country must spread its effect over all; for much local inflation, by expelling any exportable money such as gold, leads to inflation abroad. We cannot expect investigations by individual nations to be made by a sufficient number of nations or any one nation to make international comparisons for all. A few attempts at international comparisons on the cost of living have been made (as by Carroll D. Wright, when United States Labor Commissioner, and more recently by Dr. Shadwell in England and by the British Board of Trade). But the results are meager and confined to a very few countries. Moreover these results are little heeded outside of the particular nation making the investigation.

It is almost as absurd for any one particular locality or State, on the basis of its own experience, to discuss the world-wide rise in the cost of living, as it would be for a village on the Bay of Fundy to discuss the rise of the tides. They experience this rise, but its cause lies far beyond their vision or control.

WHY THE COMMISSION SHOULD BE OFFICIAL.

The commission should be official in order to secure the requisite funds for so broad a study. No private person or institution can afford to make the necessary investigations in all the great countries of the world, just as no private person or institution can afford to make a census. It is true that our best statistics today are official statistics, and this will be increasingly true in the future. Another reason why the commission should be official is that an official commission has many times the influence of private persons or institutions.

The work of the commission should be intrusted to a small staff of experts working in co-operation with the local statistical agencies of the various governments represented and acting on plans approved by the commission.

As a possible result of the work of the commission there might be established one or more permanent bureaus to continue these studies; for the need of more complete statistics of wages and prices is increasingly felt every year.

THE PRESENT A VERY OPPORTUNE TIME TO SECURE SUCH A COMMISSION.

There is now a world-wide interest in the subject, not only in academic circles, but also among business men, bankers and railway men, public officials, members of Parliament, labor leaders, and the public press. During the last few years there has been an enormous output of literaure on the subject—in statistical works and journals, in popular magazines and in newspapers, and in official reports. The Verein für Sozialpolitik in Berlin is planning to make some studies of prices during the last twenty years. It has secured the co-operation of the German Statistical Office, which in turn is in correspondence with the statistical offices of other countries. The International Statistical Institute, consisting chiefly of the world's official statisticians, is also engaged in an international study of price movements. Several governments, such as the United States through its Senate, the State of Massachusetts, the Dominion of Canada, and France have made recent reports on this subject; others, such as the government of India, are about to undertake similar studies.

The deep public interest in the question of the cost of living is expressing itself also in many other ways, such as resentment against taxation, strikes, bread and meat riots, and other demonstrations of discontent, as well as in changes in political life, to which a great part of social unrest is due. It is therefore an urgent need to find a scientific basis for any reforms which State legislation may be asked to contemplate.

In view of the colossal proportions of the problem and its significance to hundreds of millions of human beings and in view of the present world-wide interest in it, and in view of the ominous prediction of many experts that the rise of prices is to continue in the future, it is submitted that to secure such a commission as is here proposed is worth the best efforts of all public-spirited citizens.

The Perpetual Calendar - Its Reproduction as a Lost Art

By L. J. HEATWOLE, Co-operative Observer U. S. Weather Bureau.

WHO would not think the mechanic eccentric and even foolish, who uses a foot rule of different standard lengths for measuring distances in space or over surfaces? Yet such a principle is being applied from year to year by the calendar maker who enters 31 days for some months, 30 for others, and 28 or 29 for another.

It seems a far more rational proposition to use the natural unit of seven days, or that of a month of 28 days as a system of time measure for the recording of the world's daily events. The irksome and most unsatisfactory method so long in use with the almanac maker for having the fractional part of a week to appear at the beginning and close of a month or year, is very much out of harmony with modern civilization along hundreds of other lines.

That the principles applying to a universal as well as to a perpetual form for the calendar, were solved by the ancients to perfection, and the results appropriated to public as well as domestic affairs for thousands of years during the first and earliest epochs of world civilization is deduced from the following facts and observations:

In the earliest history of Egypt, whose beginnings date so far back into the past that her perspective becomes utterly lost in the dim distance, there comes to us the account of a calendar that was in use during the entire 4,000 years of her golden age.

From Plato's interesting story of Solon, the Greek

lawgiver's visit to the priests of Sias, who appear to have had their home in a city of that name at the head of the Nile delta, comes the information of a calendar being in use there that determined the length of the year with an accuracy and precision unknown to the philosophers and astronomers of other nations.

And again we note that in ancient Thebes which according to Herodotus extended for 33 miles along both sides of the river Nile, and formed perhaps the greatest center of population the world ever produced, there was a calendar in use that measured time by a system of dates so true in its relation to the motion of the sun and the change of seasons, that it would have been impossible for man to reach such a result except by a series of observations covering a vast and greatly extended period of time.

To ancient Egypt belongs the credit for developing the perpetual form of the calendar; while the division of the week into six days of labor followed by one day of rest, comes down to us from the remotest period of antiquity.

From evidences brought forward by archæologists from Egyptian and Mexican ruins, the rational conclusion is reached that this ancient calendar was not only perpetual in form but was in universal use with several other nations sprung from the same common origin from which the Egyptians trace their beginning.

In this calendar appears the provision for a cycle of five years, of which four were each composed of exactly 52 weeks—while to the fifth year there was added at the end an intercalary week in which no social or national events were recorded, but such time was wholly occupied in the observance of religious ceremonies.

There being an excess of 7 days in every 45 years under this arrangement, it became necessary to omit an intercalary week with every 45th year. In this way the calendar was made to stand in good balance with the true length of the year. The months were of uniform length—while the weeks maintained a stationary position in each month throughout the year. It was this happy feature that gave to the ancient calendar its perpetual form for all time to come; and were this system which so ingeniously introduces the week as the unit of balance still kept in practice, the world might to-day be enjoying the benefits not only of a perpetual but a universal calendar.

With the introduction of the Greek calendar and the one later adopted by the Romans, the perpetual form and other commendable features of the original calendar have been lost to all the nations of modern periods. Since the Greek and Roman conquests the world for more than 2,000 years has been struggling through the maze and tangle arising from the use of a calendar whose months are of unequal length, and where the week shifts from month to month and from year to year in its relation to dates—a system much like that which the dry goods man would find in the use of several yardsticks of unequal length for measuring a single piece of goods.

From year to year the almanac maker has encountered the needless inconvenience of shifting the days of the week out of the relation in which they stood to the dates of the month during the previous year. In the reconstruction of the calendar a system of dates should follow that restores the week to its ancient position as a stationary feature of the month as well as the year.

Granting that the leap day system of the Gregorian calendar forms a tolerably correct estimate for keeping the year in balance with the seasons, and with the discovery that the perpetual calendar of the ancients accomplishes the same result in the use of the week as its unit of measure, the two forms readily admit of a combination in which the columns of dates can stand side by side—the one preserving its records exclusively for the past, while the other comes for the establishing of its own records for all time to come.

Knots and Splices

THE latest addition to the curricula offered at the Massachusetts Institute of Technology is a course in knots and splices. This has been arranged for at the suggestion of Major E. T. Cole, U. S. A., the new instructor in military science, who will conduct the course personally. When one considers how closely the engineer is related to work of construction in which, especially in the field, such things as trestles, gins, shears, holdfasts, and even rafts of planks or barrels are of daily occurrence, the need of a good knowledge of knots and lashings will be seen to be necessary.

Something like two dozen knots, bonds and hitches will be shown, the appropriate use of each as well as the very important precaution of avoiding knots that are unsafe. The course is based on that taught to the students at the Fort Leavenworth Army Service School. As regards the method of teaching, Major Cole proceeds on the theory that the acquisition of facility in such things as this is largely a matter of automatic memory, and that therefore short lessons at considerable intervals are best.

Trade Notes.

Silver, Gray, (also Japanese).—This alloy is made from equal parts of copper and silver, boiled in a solution of alum with blue vitriol and verdigris.

Driving Belt Dressing.—(*a*) One part melted tallow, 3 parts train oil, 1.5 parts melted rosin. (*b*) Two parts of raw tallow, 1 part of train oil, 1 part technical castor oil.

Durable Whitewash.—Slake quick-lime with salt water and reduce with skimmed milk, so that it is thin enough to lay on. This is a durable whitewash, which has the advantage of rendering wood non-inflammable.

Drying Oil (according to Hermann.)—One thousand parts of linseed oil is heated with 10 parts of hydrated manganic oxide until it fumes slightly and kept for 15 to 30 minutes at this temperature. This effects a very rapid drying of oil paints thinned with it.

To Color Turquoise and Other Precious Stones (according to A. Kühne.)—The stones are cleansed or bleached in a bath, prepared with tartaric acid and blue or green vitriol, and then gradually colored in alcohol by a gradual addition of aniline dyes soluble in water.

Cleaning of Vessels, Vats, etc.—The disagreable odor of creosote, cod liver oil, petroleum and other substances can easily be removed from vessels of any kind, mortars, etc., by boiling black mustard, meal and water in the vessel, and allowing it to stand aside for a while.—*Pharmaceut. Zeitung.*

Glowing Pictures.—Dissolve 40 parts of saltpeter and 20 parts of gum arabic in warm water. Use this solution to trace out with a pen the outlines of the picture on white paper. All lines must connect with each other and somewhere must touch the edge of the paper. As the drawing can not be seen, the spot where it touches the edge must be marked with a lead pencil. If this spot is touched with a burning match, the paper will glow along the lines traced, bringing out a scorched picture.—*Neueste Erfind. u. Erfahr.*

Ignition Mass.—Rosin of inferior quality is strongly heated until it begins to smoke. Then coarse sawdust and shavings are added in small quantities at a time, and well mixed. The content of the vessel is then emptied on a stone slab and rolled out in sheets ½ inch to ¾ inch thick. These are cut up with a hot knife in pieces ¾ inch wide and 1½ inches to 2 inches long. The pieces if touched with a lighted match will at once blaze up. They will quickly ignite coal and can therefore be used to kindle a fire.—*Neueste Erfind. u. Erfahr.*

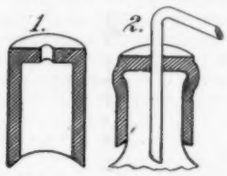
To Bleach Ostrich Plumes.—(*a*) Bath.—Permanganate of potassium, 4 to 5 parts in 1,000 parts of water, to which an equally strong solution of sulphate of magnesia may be added. Do not heat over 60 deg. Cent. (140 deg. Fahr.). The plumes, coated with a film of peroxide, are washed and finally treated with sulphuric acid of 1 deg. to 2 deg. Be. (*b*) Bath.—Peroxide of barium, 10 parts in water 1,000 parts; heat to 30 deg. Cent. (86 deg. Fahr.) allow the feathers to remain in the bath 48 hours; wash, pass through a weak hydrochloric acid bath and dry.

Japanese Seals.—Japanese seals (han) are made of wood, stone or metal, with characters or signs engraved or cast on the face. They are used in addition to a signature to represent an individual, a legal person or a corporation. The seals of the present emperor are distinguished as privy and State seals. They are each 3 inches square. The State seal is used mostly upon documents relating to foreign countries and has Chinese characters engraved on it; the privy seals are stamped on imperial rescripts, issued for proclamations at home. Japanese law require that each individual should send in an impression of his seal as a specimen (called jitsu-in) to have it registered and kept in a government office (district office or a city, town, or village office), that it may represent himself in a deed. The material employed to make these seals consists of various kinds of precious stones, gold, silver, etc.; those mostly in use at the present day are of agate, rock-crystal, ivory, rhinoceros, or buffalo horn, shell, marbles, or of cherry-wood, box-wood, and recently India rubber has come in use. There are two ways of engraving characters on a seal, relief and intaglio; in the one the characters in the impression are shown in color, while in the other they are presented in white on colored ground. The ink used for stamping is called niku. It is generally of vermillion red and prepared as follows: 10 parts of cinnabar and 8 parts of castor oil are kneaded for about 20 minutes. The bleached moxa and a little powdered alum are added gradually. This mixture is somewhat stiffer in summer and softer in winter. The cheapest kind of seals are made of box-wood and sold at 5 cents a piece. Most seals are oval in shape, but some are round and others square. They rarely exceed ⅓ inch in diameter.—*Japan Magazine.*

Science Notes

Average Speed of Parachutes.—In a note communicated to the Académie des Sciences, Ch. Bouchard gives a study of the average speed of parachutes. Starting from the hypothesis that the speed of falling is dangerous when it attains eight meters per second, and that if we designate the total weight by P, and by S the surface of the horizontal projection of the lifting plane on which the air acts the ratio $\frac{P}{S}$ is variable, M. Bouchard sought to determine experimentally a certain number of falling speeds between the values 0.1 and 0.4 of that ratio. In these calculations P is reckoned in grammes and S in square centimeters. Applying the formula of the resistance of the air $R = \phi S V^2$, ϕ being the coefficient of resistance of the air, when the movement is uniform we have $R = P$, from which we deduce $P = \phi S V^2$, whence $\phi = \frac{P}{S} \times \frac{1}{V^2}$. The author, however, came to the conclusion that V could not enter the formula with the exponent 2. If we give V the exponent 3/2 and consequently have $\phi = \frac{P}{S} \times \frac{I}{V^{3/2}}$, the values of ϕ deduced from experiment vary little from each other and are comprised between 0.0172 and 0.0193. The value 0.019, which represents within approximately two ten-thousandths, the coefficient of resistance of the air, corresponds to the falling speeds which do not attain eight meters per second.

A Substitute for Bottle Stoppers.—Van Heigendorff recommends the use of paraffin or rubber stoppers having an inner glass body. They can readily be made by covering an old glass stopper having a ground cone with a piece of rubber tubing or a thick coat of paraffin. Instead of solid stoppers, there have recently been



put on the market caps made of rubber. They are shaped as shown in Fig. 1, either plain or with a center hole, and are slipped over the bottle or flask, as shown in Fig. 2. These caps not only cover up the bottles more hermetically than the ordinary tapered stoppers, but also fit, within limits, to necks of different sizes.—*Chemiker Zeitung.*

The New Department of the Japanese Industrial Laboratory.—The most recent addition of the industrial laboratory, Tokyo (under government control) is the Fifth Department, which serves the electro-chemical industry. This has by now become the most interesting and important branch of the chemical industry in Japan, producing large amounts of caustic soda, chlorates, nitrates, carbides, calcium cyanamide, phosphorus, aluminium, etc. As there is natural water and raw material in abundance, the development of this new branch is of great importance to Japan. To call attention to this subject and to carry out necessary experiments, the Government decided last year to establish the electro-lytic department as the fifth department of the institution. Accordingly a brick building was set up as a laboratory, and a modern building for an experiment room, employing extra high tension current, a switchboard room, an electric furnace room, a transformer room, a storage battery room and a finishing room. Besides the above buildings, there is a storehouse and a workshop. As to the program of this department, it may be mentioned that work has been begun on the experimental preparation of potassium chlorate from the chloride (obtained as a by-product from the manufacture of iodine from kelp), of aluminium from certain kinds of clays, and of chlorine compounds, to utilize the chlorine is produced in the electrolytic preparation of caustic soda. As far as experiments go, the results are very promising.

TABLE OF CONTENTS

PAGE
Reindeer Progress in Alaska.—By Walter E. Beasley.—4 illustrations ... 17
The Marine Steam-turbine from 1894 to 1910.—II.—By Hon. Sir Charles A. Parsons.—3 illustrations ... 18
Automatic Telephone Exchange System.—I.—By W. A. Aitken.—6 illustrations ... 20
Aerial Engineering.—By A. Lawrence Rotch ... 22
The Automobile of the Air ... 23
Oxygen Gas in the Arts and Industries.—By August S. Neumark.—2 illustrations ... 24
American Association for the Advancement of Science.—By William H. Halo ... 27
Scientific Papers ... 27
New Successes in Long Distance Transmission of Photographs ... 28
Insects which Devour Metal ... 28
An Improved Method or Chipping Trees in Turpentine Orchards.—1 illustration ... 29
Professors and Practical Men ... 29
The Adherence of Flat Surfaces ... 30
International Commission on the Cost of Living ... 31
The Perpetual Calendar ... 31
Trade Notes ... 32
Science Notes ... 32